THE NATURE STUDY COURSE

SILCOX AND STEVENSON

9/48

PUBLIC SCHOOL FLOWER SHOW, ST. THOMAS, ONT., SEPT. 22nd, 1905

Three classes of exhibits. I—Flowers and vegetables raised from seeds distributed to pupils in spring ; II—Flowers and vegetables raised by pupils from seed ; III—Flowers and vegetables raised on city lots.
The white asters on the right hand side, half way back, were raised on a school plot at Balaclava Street school.

(See page 16.)

THE
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BY

SIDNEY SILCOX, B.A., D.PAED.

INSPECTOR OF SCHOOLS, ST. THOMAS

AND

O. J. STEVENSON, M.A., D.PAED.

ENGLISH MASTER, COLLEGIATE INSTITUTE

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INTRODUCTORY NOTE

It has been the aim of the authors of *The Nature Study Course* to prepare a manual which might be found suggestive to teachers in the various provinces throughout the Dominion. Unfortunately, however, the Courses prescribed for the different provinces, though substantially agreeing in general character and scope, differ in form and details. As a result, the authors have found it impossible to treat accurately of the work covered by the Course of any one province. As, however, the work prescribed for Ontario is more general than that of the other provinces and practically covers the whole field, it has been made the basis of the suggestions contained in this manual. The Manitoba Course, which is the most detailed, and the Ontario Course, which is the most general, are both printed in full in the Appendix, for the sake of reference and comparison. The General Note to the Nova Scotia Course is also given in the Appendix. As pointed out in the introductory chapter, however, teachers in all the provinces are requested to consider the material contained in the manual as suggestive, rather than as an attempt to treat the subject exhaustively.

It should be kept in mind that Grades I to VIII in the Manitoba schools correspond in the main to Forms I to IV in the Ontario schools, the division in the latter being usually made with Junior and Senior in each Form.

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"I have not yet told you how heartily I agree with you in the desirableness of encouraging the study of natural history, especially among children, whose eye can be so easily educated to observe, and where restless natures must have some occupation. . . The dullest country can scarcely be dull if the human being can look with seeing eye on the things around him, the most difficult outward circumstances can hardly be without remedy if he be aware of even a small portion of the mystery and might of the nature that surrounds him. They ought to learn this practically."

—*Tennyson.*

"Study nature—not scientifically—that would take eternity to do it so as to reap much good from it. Do not study matter for its own sake, but as the countenance of God. Study the forms and colors of leaves and flowers, and the growth and habits of plants; not to classify them, but to admire them and adore God. Study the sky! Study water! Study trees! Study the sounds and scents of nature! Study all these as beautiful in themselves, in order to recombine the elements of beauty. No sight but has some beauty and harmony."

—*Kingsley.*

THE NATURE STUDY COURSE

CHAPTER I

Introduction

IT is self-evident that the style of education which is suited to one age may be entirely unsuited to another. Even in a single generation there may be such important changes in social life as to demand radical changes in educational methods. But unfortunately it is difficult to make rapid changes in educational matters. We are very often not conscious that social life has altered, and we do not see the necessity for change. Moreover, we feel the danger of experimenting with methods in education, and besides, the difficulty in making changes in the machinery of the school, text-books, time tables, equipment, etc., often prevents us from departing from the older methods.

It is now nearly a hundred years since the beginning of the great movements in social life which have almost entirely altered the conditions under which we live, and yet it is only recently that any attempt has been made to bring educational theory and practice into harmony with these changed conditions. Without discussing at length these changes in the social world, it may be sufficient to state (1) That the education of the future must take into account the masses as well as the classes, and must consider how they are to be educated for the best performance of their duties in life; (2) that it must be prepared to meet the changed

commercial and industrial conditions of the present day—the centralization of industry, the stress of competition, and the effects of rapid transit; and (3) that it must not lose sight of the social character of the individual and the necessity of preparing him to render the highest service to society.

The introduction of nature study as a subject of the school course is an effort to meet, in part, these changed conditions. Through the school garden the activities of the child are brought into play. In the study of nature he is led to consider the materials and processes of social life. His powers of observation are stimulated, and his study of the lower forms of life has the effect of broadening his sympathies for life in general.

In spite, however, of the fact that nature study now holds an established place in the school curriculum, there are still those among the public, and even among the teaching profession, who consider its introduction as a formal subject of study to have been unnecessary. In reply it may be said that in general the best teachers in the past have taught nature study, even before its formal introduction. The fact is indisputable that literature, composition, geography, and drawing, cannot be properly taught except by means of nature study. Whether formally prescribed or not, it must be taught; and it is, one may be certain, from the most inefficient teachers that the greatest objection is sure to come. So-called teachers, who follow only the bare letter of the curriculum, are sure to object to any innovation as a probable addition to their work.

Nature study has to meet the opposition of the humanists; that is, the worshippers of literature. They are willing that the student of literature should verify the statements made by Wordsworth or by Bryant regarding nature. To them nature study is

useful to interpret literature, but useless to inspire it. They forget that Wordsworth and Bryant were nature students *before* they wrote their poetry. Why should there not be a Wordsworth and a Bryant, a Shelley and a Whittier in every generation? There will not be, if we are to consider nature useful only to interpret that which has already been learned about her. One sees what one looks for. If a man studies nature through another's eyes, he will see no more and much less; errors will be perpetuated, and discovery most effectually suppressed. The evil effects will not be confined to any one subject, but will affect the whole habit of study.

But there is no doubt also that a certain amount of misapprehension exists on the part of the average teacher as to what is required of him in connection with the course; and a few suggestions as to some of the mistakes that are frequently made, may help to remove some of the difficulties that are in the way.

1. In the first place, it cannot be denied that the nature study course, even as laid down in the official course of studies for each of the provinces, is elastic in the extreme. The teacher who attempts to cover the prescribed work in an exhaustive manner will find that by far too much of his time will be taken up with this one subject. He must, then, be judicious in his treatment of the work prescribed. Much of the course will necessarily be covered incidentally in connection with other subjects—literature, geography, etc. It will, moreover, often be found sufficient to give suggestions, or to consider only a single type of the plants, birds, insects, etc., to be studied. The pupil who has grown a single plot of lettuce, or a single row of sweet pease, has learned the elementary facts concerning conditions

of soil, germination, growth, etc., and should be able to apply these facts to the work of the garden in general.

2. It must not be forgotten that what the child *does* is of infinitely more importance than what he *knows*. The teacher who wishes to be successful in nature study work must learn at once how to direct the activities of the pupil in connection with the school garden, the aquarium, the terrarium, the cross-country excursions, etc. There are, it must be admitted, certain parts of the prescribed work in which the child's activities cannot be called into play, but this is distinctly the most unimportant part of the work, and should call for less time and attention, on the part of both teacher and pupil, than the other sections of the course.

3. The different divisions of the nature study course must be correlated. It is impossible to treat of them successfully as separate unrelated subjects of study. The study of the codling moth, for example, involves, of necessity, the study of the apple upon which the larva feeds, of the bark upon which the pupa fastens, and of the downy woodpecker which destroys the pupæ. The consideration of any object in nature involves a study of its surroundings.

> "All are needed by each one;
> Nothing is fair and good alone."

And the attempt to teach separate isolated facts is sure to destroy vitality and prevent a proper interest in the work.

4. As is pointed out elsewhere in the following pages, the teacher must guard against over-analysis and minute dissection. The object of nature study is not scientific accuracy, but a living interest in the actual forms and activities of nature. Facts that are

trivial, or technical, or so plain as to be obvious to all, should not be considered unless they bear an important relation to other important facts.

5. As nature study must be based upon the activities and experiences of the child, it is evident that it must, if possible, find its materials near home. The pupil must in the first place become acquainted with the birds, animals, plants, insects, soil, etc., near the school, preferably in connection with the school garden. When these are exhausted it will be time enough to go farther afield. Unfortunately much of our literature on nature deals with the remote and the uncommon, whereas there is abundant material near at hand to interest and instruct, and in the world of nature, as well as in other departments of life, it is generally true that the "best things lie close about our feet."

6. The teacher who follows the general rule that nature study must be based on the activities of the child, will not make the mistake of attempting to teach things out of season. It is not necessary that the exact order laid down in the course of study should be slavishly followed without regard to natural conditions. It is useless to attempt to deal with autumn leaves in the spring, or with bees in midwinter. Under each division of the school course there are subjects particularly fitted to different seasons of the year, and the successful teacher will so arrange his work that the subjects of study will be appropriate to the actual existing conditions.

7. Care must be taken that individual lessons do not cover too much ground. It is impossible, for instance, to treat of such a subject as *Winter Birds* in a single lesson. The consideration of a single winter bird, such as the English sparrow or the chickadee, is sufficient for a single lesson, or for a number

of lessons. And in the study of any object in either animate or inanimate nature it is well to remember that the subject cannot be treated and finally dismissed in a single lesson. Nature is continually undergoing change, and, moreover, in many cases, in animal life especially, it is impossible to have the object of study under continuous observation. It may take a whole year to study the robin, or the honey bee, or the codling moth.

8. It is impossible to lay down rules to define accurately the limit of work in the various grades. The experience and judgment of the teacher are the best guides; for much depends on the character of the individual school, and on its position and surroundings, as well as on the character of the pupils. The teacher should bear in mind that it is the interest of the pupil in nature that is important, and not the number of facts which he acquires, and this should be a sufficient check on the tendency to cover too much ground and treat the subject too exhaustively in the lower grades.

In connection with the various points indicated in the foregoing paragraphs, the teacher should pay particular attention to the general instructions as to the method of dealing with the subject of nature study, as laid down in the Public School Programme of Studies for Ontario:

"From the character of the subject, the course must be more or less elastic, and the topics detailed in the programme are intended to be suggestive rather than prescriptive. It may be that, owing to local conditions, topics not named are amongst the best that can be used, but all substitutions and changes shall be made a subject of consultation with the Inspector. The treatment of the subject must always be suited to the age and experience of the pupils, and to the seasons of the year, accessibility of materials, etc. Notes shall not be dictated by the teacher. Mere

information, whether from book, written note, or even the teacher, is not nature study. The acquisition of knowledge must be made secondary to awakening and maintaining the pupil's interest in nature and to training him to habits of observation and investigation. Books for reference and supplementary reading should, however, be provided in the school library. Some valuable publications on the subject of nature study, for the teacher's use, may be obtained free, on application to the Ontario Department of Agriculture, Toronto."

CHAPTER II

The Various Methods of Teaching Nature

FROM various sources we have become acquainted with the sugar-coated, the information, the observation, the scientific and the practical methods of teaching nature. In addition to these there is a class of teachers who believe in no method at all. Since nature is all around the child, these advocates of no-method study (in spite of evidence to the contrary) think that the child will become saturated with *nature*.

The adherents of the sugar-coated method believe in presenting the facts of nature in the form of storiettes, or fables, or in animal dialogue. Of these, the stories of animal life by Thompson-Seton, Fraser, Roberts, Long and Clara Pierson are classic examples. Needless to say, these are all right in their place. One should read nature literature, but only after having sufficient experience with nature to be able to interpret from within his own consciousness the writings of these master observers of animal life. When this method is applied to plant life, the result is truly disgusting to the real student and teacher of nature.

The followers of the information method scorn the presentation of natural facts in sugar-coated doses. They believe that nature has an intr nsic interest, and, believing that one cannot have too much of a good thing, they aim to make their pupils acquire an encyclopedic knowledge of nature. Facts are to be learned from every source,—from books, from the teacher, from nature, from any source—but facts must be

learned. Training is secondary. Consequently, such a method is of no more value than the learning of Latin paradigms. Indeed, if one must acquire facts in this way, it would be far better to learn Latin and Greek paradigms and conjugations than the concrete facts of nature.

The teachers who practise the observation method take one step in advance. They are after facts, but these facts must be acquired through the senses, chiefly sight and hearing, though smell, taste, and touch are not to be despised. They have probably never heard of any other senses than these five. These teachers usually seek to help their pupils along the flowery path of nature knowledge by extreme analytic questioning. The questioning is exhaustive and exhausting.

EXAMPLES—

How many leaves has this plant?
How many lobes on each leaf?
How many teeth on each lobe?
How many feet has this animal?
How many toes on the right fore foot?
How many toes on the left hind foot?

Account for the difference. Compare with the dog, the cat, the cow, the horse, the sheep, the pig, the hen, the mouse, the rat, and man.

What is the length of its tail? Of its whiskers? Why?

These teachers take their pupils on observation excursions to the woods, to parks, and to ponds and lakes. They count the pebbles on the shore and the waves upon the lake. They catch fish in order to count the fins and the number of rays in each; to examine the teeth and gill-rakers and compare them with the teeth and gills of other fish, and with tadpoles.

Next comes the class of teachers who advocate the scientific method.

Reforms usually begin at the top. After centuries of poring over books had passed, a genius arose who advised a return to nature. The universities heard the call first and laboratories sprang up where campus and grove had formerly delighted the eye and fostered the love of sport. The students deserted the campus, with its freshness and beauty, for the fumes and ugly retorts of unventilated basement laboratories. Then the high schools heard of the demands of the universities and immediately seats were removed to give place to sinks, pipes and Bunsen burners; to rows of chemicals and glass-topped counters. Then, lastly, the public schools heard of the new learning in the high schools—but laboratories in public schools were impossible. Some enthusiastic teachers thought to make one room serve the purpose of dissecting room, hydrogen sulphide generator and gas manufactory—with disastrous results in school and at home. At last a new genius arose who discovered nature outside the school-house—a natural laboratory of sights, sounds and chemical changes, beyond the power of man to imitate. The return to nature was accomplished in the public school. But, nevertheless, the scientific method of the university and the high schools is still overshadowing the true study of nature. In botany it shows itself in the time spent on classifying and in describing, by means of carefully ruled schedules, each plant brought from its habitat to wilt and die upon the laboratory altar. In zoology, the scientific method shows itself in the dissection of repulsive alcoholic specimens or in experiments on living animals in unnatural environments. The scientific method has no place in nature study, though nature study is indispensable to the successful study of science.

Opposed to the scientific, and indeed to all other teachers, stands the unscientific or no-method teacher. The exact methods of the laboratory are an abhorrence to him. He has no aim. There is no unity in his method. One day he serves up the sugar-coated nature pill; the next, he reads Thompson-Seton's *Story of a Grizzly*; the next he gives a talk on the raising of wheat in connection with a problem in arithmetic requiring the reduction of so many pounds of wheat to bushels. No effort is made to organize the facts learned. No attempt is made to remember them. The teaching is neither utilitarian nor academic. The unscientific teacher makes nature study an excuse for shiftlessness, and quiets conscience by deceiving himself into believing that sometime, somewhere, somehow, his efforts may bring forth fruit, though all is barren now.

But in addition to these methods there remains the practical method or *the* method. *The* method of study in any subject must be based upon the interests of the child — not upon secondary, but upon fundamental interests. The fundamental interests are, in order of development, love of activity, family interests, community interests, property interests, artistic interests and religious interests. In connection with all these, there must be immediate application of these interests to secure a definite, immediate, concrete result. In order to make such application there must be a knowledge of the result desired, and an intelligent, more or less independent, manipulation of means to secure it. In later life pupils should invent or discover. He who learns all that has been discovered, is a wise man, but he who learns just enough of it to lead to the discovery of new knowledge, is a genius. We have been laboring to educate wise men. Henceforth let us

turn our attention to the production of geniuses. *The* method aims to develop genius. We have called this method of nature study *The Practical Method.*

This method makes nature study a part of daily experience, of family, community and active interest, leaves the child scope for invention and discovery, gives a motive of perennial interest—as perennial as the seasons themselves—appeals to the inner man and to the artistic sense, and develops property-ownership, which leads to respect for the property of others. It provides the conditions for developing the moral virtues, and opportunities for daily practice of them. Is there really a method that will accomplish all these desirable results? Yes, the method awaits the teacher—and the teacher is the only weak link at present in the chain of development. A good teacher is above curricula.

"If so be, you don't believe in God, Mr. Bennett, owin' to town opinions, you try the gardenin' business. That'll make a man of ye! I allus sez if Adam had stuck to the gardenin' business and left the tailorin' trade alone, we'd have all been in Eden now!"
—Marie Corelli, in *God's Good Man.*

The practical method begins in the soil, grows in the soil, and builds upon the solid soil. It begins in the garden, and ends in eternity. Put your pupils in the garden, or on soil in which a garden may be made. Let both them and it develop, for without development there is no education. The development and its history as they occurred in a Canadian city are given herewith.

In this city, nature study started with the observation method, beginning with mineral specimens in connection with geography. Specimens of about one hundred different native rocks and minerals were obtained and kept in suitable cases. These specimens were obtained from the Geological Survey

Department at Ottawa. In addition to their usefulness in teaching geography, the minerals and rocks suggested the establishment of a museum. Cases were accordingly built in private rooms; children brought specimens that had lain around the home fireplace or bric-a-brac corner for several dusty years. Pupils or teachers who had friends in manufacturing concerns, obtained from them samples of the different stages through which the raw material passed to become the finished product. The cocoa bean and the stages of manufacture into cocoa and chocolate were shown. Spruce wood and the stages of manufacture into pulp and into paper were exhibited. Some Indian relics and natural curiosities were presented. A collection of birds, which had stood for many years in a store window, in a glass case, was purchased. One pupil brought a duck-billed platypus, which had been donated by an interested friend. A parent donated a fine specimen of the white owl. There were in time, squirrels, badgers, a beaver, a peacock, silk-cocoons, birds' nests, eggs, grains, and colored pictures of birds and mammals. Still the real discovery of nature was not yet.

Meanwhile nature study was discussed; insect larvæ were brought by pupils and eagerly watched during their transformation into pupæ and adults; these were prepared as mounted museum specimens; tadpoles were secured and their development observed and described with absorbing interest; mud-turtles and snakes were captured and brought to school to be observed for days. At last one teacher of agricultural lineage planted some wheat, as did the now famous "red hen." The sprouting and growth of this wheat proved so interesting that another teacher planted some pansies, and still another teacher transformed a barren school-room into walls and banks

of living green, which later blossomed, in company with the minds of a delighted and happy class of pupils. The discovery was almost made.

Finally at the spring session of the Teachers' Association this question was asked, "Shall we distribute seed to the pupils and have a flower show?" The answer was in the affirmative. The following selection was made for each grade from the lowest to the highest public school class:

Grade 1.—Nasturtium.
" 2.—Balsam.
" 3.—Calliopsis.
" 4.—Centaurea.
" 5.—Sensitive Plant.
" 6.—Ageratum.
" 7.—Ten Weeks' Stock.
" 8.—Verbena.

Teachers.—Asters and Chrysanthemums.

Each pupil received from five to ten seeds (too few) according to the size of the seeds. Out of about 10,000 seeds distributed, 520 plants were successfully raised, and these were exhibited on the 24th of June, 1904.

From reports received from teachers, a few definite results may be stated. A girl, fourteen years of age, in the highest grade, had never exhibited any interest in any subject of school study. She received seeds and planted them. After they had come up and were growing satisfactorily, she came to her teacher and, with manifest interest, informed him of the progress of the plants. She seemed to take more interest in her other school studies and was successful in passing her examination into the high school at the end of the term. One such result is worth 10,000 seeds!

In several cases, pupils, unfamiliar with the seedling which should appear, raised weeds to maturity.

Such an experience should arouse a desire to know plants in order to distinguish weeds from beneficial plants.

One teacher reports: "It established a new interest between the home and the school, and helped to interest both parents and children in school work. A much greater interest has been manifested in plant life this spring."

Will some one estimate the value of this new interest between the home and the school? Was it worth 10,000 seeds, which cost $3.36? Could this interest be aroused by a scientific description of *Malva rotundifolia?*

Another teacher reports: "The pupils have shown a greater interest in wild flowers this spring. Some have planted other seeds and have closely watched their development."

The second year, flower seeds and vegetable seeds were distributed as follows:

Grade 1. Nasturtium and Parsley.
" 2. Pansy and Sweet Corn.
" 3. Centaurea and Sugar Beet.
" 4. Phlox and Celery.
" 5. Canadian Peanuts and Verbena.
" 6. Asters and Catalpa.
Grades 7 & 8. Cosmos, Asters and Broom Corn.

The result of this distribution was seven or eight hundred plants. The most remarkable results were obtained from broom corn, plants 9 to 12 feet high being grown in four months from seed to seed. Perhaps this proof of its rapid and successful growth may result in some new industry in this community, in which there is a large broom factory.

The distribution of the seeds gives teachers an opportunity for teaching lessons on soil and on gardening. Questions will be asked by the pupils, and

the means of learning the answers may be suggested by the teachers.

A flower and vegetable exhibit was held on September 22, 1905. The success of this exhibit was beyond the expectation of all who promoted it. The different schools were assigned space in a large store, and teachers and pupils vied with each other in decorating and exhibiting. All the citizens turned out to encourage the children, but eventually to admire the beautiful arrangement of flowers and plants.

In addition, in this same year, three out of five schools prepared and planted plots of flowers on the school grounds. One school covered a fence with vines, and had very presentable flower beds in both the boys' and the girls' yards. A class in another school planted aster seeds, and did all the work required. The result was a bed of white asters from which fully five hundred asters were exhibited on the above date. A class in a third school subscribed money, bought plants, and, aided by friends who contributed seedlings of various kinds, succeeded in producing a flower bed that was equal to any in the city. It was three feet wide and seventy feet long.

These three beds remained in the centre of populous districts and were unmolested from the day of planting till the frost came. Two of them were adjacent to the boys' walk, with nothing but a slender wire separating them from the walk; yet, no damage was done them. This means that the boys must have restrained much of their play to avoid damaging the plants.

To develop a proper respect for the property of others, boys and girls must own and care for property.

"But the raising of a few plants every year will not cover the course in nature study as outlined by the Department," some one will say. Quite true. But there is scarcely an object of study mentioned in

that course that will not force itself upon the child's attention if he begins to raise plants in a garden. If he plants corn, or lettuce, he will find something cutting holes in the leaves. He will want to know what it is. Investigation will prove it to be the work of slugs. The study of the slug is then in order. What other signs of their presence are there?* Their slimy tracks can be seen on ground and leaves. Why do we not catch them at work? They eat at night. How do they eat? How do they see? How do they travel? New facts will be gathered from day to day about the slug. In the course of time the pupils will discover where it stays during the day, what it does all winter, where it lays its eggs and what they are like, how it breathes through its side, keeps its eyes in pockets when not in use, and is not a snail escaped from its shell, though the snail is closely related to the slug. See *Morang's Modern Nature Study*, pp. 104-108.

Before all this is learned, the pupils will wish to know how to get rid of these destroyers of corn, lettuce, tomatoes and other succulent garden products. The toad should be introduced at once as a subject for nature study. Secure a well-grown toad; keep it in the school terrarium for a day or two without food; then introduce some slugs. As they go crawling about, seeking for shelter, the toad will awaken to its opportunities. It may not be very anxious to seize the slugs until the strangeness of its surroundings wears off, but time will make it feel at home. The study of the toad or frog from egg to adult is the easiest and most interesting of nature studies. *See Morang's Modern Nature Study*, pp. 88-93.

*In some cases in the treatment of the subject, suggestions have been put into question form. These questions are intended primarily, of course, as hints to the teacher as to the work to be covered, and should be modified by him, where necessary, to suit the needs of his classes.

Let pupils estimate the value of a toad to the gardener. Once convinced that toads and frogs are valuable animals with a mission in the world, boys will cease throwing stones at every frog that shows its head above water in the pond. The old fable which ended with the moral, "It may be fun for you, but is death to us," is not half so useful in securing the frog's safety as a well-conducted nature study lesson, or series of lessons, in connection with the work in the garden.

From what has been said the reader will readily see what is meant by the practical method, and we will not attempt to illustrate further. The authors believe that the ideal course in nature study, which may be realized within the next ten or fifteen years, will consist of an outline of work to be done by certain grades in the schools. Along with instructions regarding the work to be done, there will be suggestions as to probable plants and animals that may be met with. Actual results, as worked out with classes of pupils, will be given as a guide to inexperienced teachers. The correlation of nature study, art, arithmetic, manual training and domestic science will be the most valuable feature of the course. At present, however, and for many years to come, it will be necessary to be guided by the courses at present laid down by the various Departments of Education. Many things must be studied for the sake of interesting the pupils in their beauty and use, though the pupils may not have the opportunity of really doing anything beyond examining them. Accordingly, we have tried in the following pages to show how the present course can be satisfactorily covered in schools as at present organized.

CHAPTER III

Form I—Animal Life. Lesson Plans. Care of Buds, Leaves, Plants and Fruits.

THE study of birds and mammals, on the part of the pupil, should have at least two well-marked results. It should, in the first place, give him a clear idea of the relations existing between man and the lower animals. He will learn that man is dependent on the domestic animals, in part at least, for labor, clothing and food; upon the wild animals for fur, and upon animals and birds alike for protection from destructive and troublesome insect pests and injurious weeds. From an economic and commercial point of view, therefore, there are many important facts to be presented to the pupil.

But there is another side of the question which must not be forgotten. The pupil should gain from the study of animal life, not only a multitude of facts important in themselves, but also a training in character which is of inestimable value. One of the things which the child too often lacks is a proper respect for the life and property of others, and a due sense of responsibility for the care and welfare of other forms of life. How often we hear it remarked that children are by nature cruel, and how often instances are brought to our notice of the wanton cruelty of boys in the way in which they torture and persecute the different creatures that come within their power. But if once the child is admitted to a share in the responsibility for the welfare of the lower

animals, and has learned how much his own welfare depends on the welfare of others, he has taken the first step towards preparing himself for the duties of citizenship which must come later in life.

The child's first introduction to the animal world must be through his pets. The treatment of the subject of "pets" by the primary teacher must, of course, depend on the conditions of the school. In the first place, however, a list of the various pets owned by members of the class should be written down. They may then be divided into two groups: (1) The ordinary tame pets, such as rabbits, guinea-pigs, pigeons, etc.; (2) wild animals and birds that have been tamed, squirrels, raccoons, crows, etc. Each pupil may be asked to tell all that he knows about his particular pet, and this may serve as an exercise in elementary composition. In some few cases it may be possible for the pupils to bring pets to school to be kept in the school yard or shed. In most cases the school-room will be found to be unsuitable for observation purposes.

In making a study of a particular animal or bird, the teacher must, in the first place, avoid the senseless mechanical method of questioning which is unfortunately so common in nature study work. Has a rabbit a mouth? nose? eyes? ears? how many? etc., etc., until the pupil is weary. As far as mental training goes one might as well ask the child to count the pickets on the school fence, or the stones by the side of the road.

It is well, however, for the teacher to have some general plan of treatment, such as, for instance, the study of the food, warmth, shelter, enemies, etc., of the particular animal to be studied. In the case of the rabbit, for instance, have the children consider: (*a*) Its food. What does it eat? grass? vegetables?

bread? meat? Look at its teeth to see how they are fitted for chewing different kinds of food. Does it ever destroy anything? Does it injure the fruit trees? How can this be prevented?

(*b*) Warmth. Its fur. Is the fur thicker in winter than in summer?

(*c*) Shelter. What sort of a rabbit house has been provided? How often is it cleaned and provided with fresh straw?

(*d*) Enemies. Principally the dog. Can a rabbit hear well? Note the big ears. Can it see well? Note the eyes in the side of the head, not in front. Can it smell its enemy? Note the constant movement of the nose. Can it fight with its teeth? Can it run fast? Examine the tracks in the snow to see how it runs. Does it ever fight with its hind feet? Have any of the pupils ever noticed it thump with its feet? What position does the rabbit take when sitting still? Why?

In treating of animal pets too much stress cannot be laid on the necessity of cleanliness, and of regularity in supplying them with food and water.

But some of the pupils may have as pets, birds or animals that have been tamed, and these form even more interesting subjects of study than the common pets. It is necessary to learn, in the first place, how the particular animal or bird was caught, how old it was when caught, how it was tamed, how long it took to tame it, how it is fed, what its habits are, etc., etc. And then the pupils may be led to interest themselves in taming certain animals and birds. But it is well to remember at the outset that it is impossible to make pets of wild animals unless they are taken when young. An old rabbit, squirrel, raccoon, robin, etc., will always remain more or less wild, and if kept at all must be

confined in close captivity. But young robins, jays, and other birds, squirrels, raccoons, and even bats and mice may be tamed quite easily if taken in time. In attempting to tame any bird or animal, however, two things must be borne in mind. First, that extreme gentleness is necessary in dealing with wild life. A sudden fright, a chase after a young bird, or rough handling, are sufficient to destroy confidence and render futile one's best efforts. Secondly, that regularity of feeding with proper food is essential. A young robin just out of the nest, for instance, must be fed at least once every hour from sunrise to sunset. The robin lives partly on worms and insects, partly on berries and seeds, and the artificial diet for the young robins should be varied accordingly, from earthworms and finely minced raw meat to berries and bread slightly moistened with milk or water. Mrs. Brightburn's *Wild Nature Won by Kindness*, should be in the hands of every primary teacher who wishes to interest her pupils in the taming of wild birds or animals.

"*Domestic animals on the farm; their care, habits, and uses.*"

In some cases it will be found difficult to draw the line between the pets, so called, and the domestic animals. But cats, dogs, horses, etc., should all be considered under the latter head. And here again, as in the case of pets, the teacher must be careful to avoid a mere repetition of useless facts concerning the animal to be studied.

In the first place a census may be taken of the number of domestic animals of different kinds at the homes of the various pupils; and a language lesson may be used to ascertain what the pupils know of them. In treating of the particular kinds of domestic

animals in detail, it would be well to consider in the first place their uses, and thence lead up to their habits and how to take proper care of them.

Let us take the horse, for example. Note its various uses on the farm and in the city. Show how machinery has taken the place of the horse in some cases. Illustrate, if possible, by pictures of the old horse power *vs.* the modern steam-thresher, the horse car *vs.* the trolley, the carriage *vs.* the automobile. What kinds of horses are used for driving, drawing heavy loads, ploughing, etc.? Note the use of the horse in the chase, and also in war. What food is necessary for the horse and how often should it be fed? Protection—Does the horse get a new coat in winter? How should it be protected from the rain, the cold, and the snow. What provision should be made for fresh air? General Care—What treatment does the horse require after driving? Should it be rubbed down? Fed and watered? How should it be tied in the stall so that it can lie down and rest comfortably? Should blinders be used? In training, should force or gentleness be used? What tricks may horses be taught to perform? How do they express themselves? Why should they be shod? Does it hurt them? How can one tell whether a horse is well cared for or not?

It is hardly necessary to emphasize the fact that these points must be treated very simply in the primary class, and in this matter the judgment and experience of the teacher are his only guide. A similar course of treatment to that outlined in the study of the horse may be followed in the case of the other domestic animals, the dog, cat, cow, sheep, etc. What good purpose does each serve?

"*Birds.—Their nesting, song, food, migrations in the autumn.*"

The great difficulty in the study of birds, especially in the primary classes, is the impossibility of observing them closely. The growth of a plant may be watched from day to day, an insect may be caught and put in a glass case, even a squirrel may be kept for a short time in a cage, but the birds have to be observed when fortune favors us with a visit from them. Moreover, in the study of birds it takes a long time, sometimes weeks, months, and even years, to make any satisfactory progress. Sometimes the teacher attempts to take a short cut by making use of a dead bird, or of a stuffed specimen. Stuffed specimens are useful for reference, but the study of dead animals and birds is not nature study. A good bird picture is to all intents and purposes as helpful as the dead specimen, and certainly the shooting of birds for the purposes of nature study is in direct opposition to one of the most important lessons which the subject is intended to teach. Excellent colored charts, showing the common land birds, are published by the Prang Educational Co., Boston, (Steinberger, Hendry Co., Toronto). A set of these should be in every school.

Another difficulty connected with the study of birds is that the conditions favorable to bird-life differ very much with different schools. Some birds are common in the country which are seldom seen in the city, and even some country schools are so situated as to render bird-study extremely difficult. In general, it can only be said that the teacher must become familiar with local conditions and study to improve them, and that he must of necessity learn to be patient if he is to accomplish anything at all.

A few birds, such as the robin, song-sparrow, wren and blackbird, are common everywhere—city and country alike—and with these he may begin. Study those birds first that are found in the neighborhood of the school. Pupils may be led to recognize them by their size, song, form, and movements. See *Morang's Modern Nature Study*, pp. 43-83.

Nesting.—In the first place encourage the pupils to provide proper nesting places for different varieties of birds. Evergreens will sometimes prove an attraction for the robins and chipping sparrows; and children are generally interested in making bird boxes for wrens, swallows, and bluebirds. In bird boxes for wrens the entrance should be an inch in diameter; for bluebirds, two inches; for martins, three inches. These bird boxes should be placed at least seven or eight feet from the ground in a sheltered spot, out of the reach of cats and other prying enemies. Martin boxes should be placed under the eaves.

Nesting materials should be provided for different kinds of birds—a pan of mud for the robin, straw for the martin and bluebird, and twigs for the wren. A bundle of cotton waste, horse hair, thread, wool, etc., may prove attractive to the orioles, warblers, vireos and other birds.

In the cities especially, a supply of food and water will help to attract the birds. Use a shallow dish—earthenware is the best—for the water. Cover the bottom of the dish with gravel, and tilt it slightly so that the water will lie from half an inch to two or three inches deep. This dish, in which the birds may drink or bathe, should be placed some feet above the ground, preferably near a window among protecting shrubbery.

The two great enemies of most of our common

birds are the English sparrow and the cat. It is practically certain that the English sparrow discourages the presence of desirable birds, and it is probable that more young birds are killed by cats than die from any other cause. If the birds are to be tamed, ways and means must be devised for protecting them from their enemies.

Song.—The pupils should notice the character of the songs—continued, broken, varied, monotonous, etc. When do the birds sing most? Where do the different species sing—on the ground, tree-top, fence, when flying? Note the songs that are said to resemble certain words and phrases. Do the birds sing all the year round?

Food.—Some of the birds eat seeds only. Some eat worms and insects. Some eat both kinds of food. What do the robins eat? Watch them after a rain. What do the swallows, the woodpeckers and the sparrows eat? Watch the English sparrows in the yard. Throw out some grain and see what birds eat it. Why do the crows and the blackbirds like the cornfields in the spring? Why do the goldfinches like the thistle patches? Do any of the birds eat the bugs and insects in your garden? Do any of them visit the flowers?

Migrations in autumn.—Which direction do the birds take in autumn when they leave us? What birds gather in flocks, and why? Why do they go away for the winter? on account of the cold weather, or because there is no food for them? Which goes first, and which stays longest? A school record should be kept, showing dates from year to year. Do any new birds come here in the winter? Where do they come from, and why? Do you see any birds in the fall that you do not see at any other season? Do you see birds flying south in flocks in the day time?

"*Metamorphosis of a few conspicuous butterflies and moths.*"

If two are selected for the fall and two for the spring term, this will be sufficient. For fall, the cabbage butterfly and eastern swallowtail for Pt. I, and the sulphur yellow and milkweed butterflies for Pt. II will answer, and in addition the polyphemus and tomato sphinx moths may be studied by Pt. II.

Keep each species in a separate box. A chalk box covered with mosquito netting and divided into two compartments will answer for two species. Supply fresh leaves of their food-plants every morning. Attention should be directed to the plant and to its leaves, on which the larva feeds. Some attention should be paid to the extent of the damage done, and, in Pt. II, to remedies. Make color drawings of the insects and of their food plants.

"*Plant Life.—Work in school garden or in window boxes. Study of a plant from slip to flower. Caring for plants in pots.*"

It is much better to plant in a plot outside than in window boxes, as so many related phenomena appear outside that do not appear inside, though window boxes in the school-room are very desirable as ornaments and for object lessons. It is better to set the window box below the window on a shelf than on the sill. Some window sills will not furnish bases for boxes, and special shelves must be used. Brackets beside the window are convenient for pots. Some teachers, where windows are numerous, train vines in one of them. This makes a pleasing variation in the factory-like arrangement of the windows.

For Pt .I pupils, the nasturtium is very suitable, and for Pt. II, the pansy. For vegetables, let Pt. I

try lettuce, and Pt. II spinach-beet (an excellent all summer green). In some districts other flowers or vegetables may suggest themselves and should be tried, but anything rare or difficult should not be attempted.

Raising plants from slips is also prescribed for Form I. For this purpose geranium or foliage plants are best. With a sharp knife cut off, just below a joint, a part of a branch of either plant. Remove the lower large leaves, leaving a few small ones at the upper end. Place in moist sand, with very little loam, and press the sand firmly about the stem. Keep the sand merely moist, not water-soaked. After roots have formed, transplant into good soil.

The common garden purslane should be studied at the same time. This noxious weed is so tenacious of life that almost any part of it left on the moist ground will send out roots and give rise to a new plant.

"*Buds.—Their preparation for winter; their development.*"

While this work is being done, attention should be called to buds. From the plants raised from slips, pass on to a study of buds on the deciduous trees, selecting the apple and maple, or lilac and horse-chestnut. Even while the leaves are on the tree the buds can be found. After the leaves have fallen, examine the buds. Notice how they are protected to prevent the moisture from drying out. Some, like the horse-chestnut, have a gummy covering; some, like the beech, are covered with scales; others, like the ash, have a smooth corky covering; while still others, like the apple, are protected by a coating of fine wool or down. Note the different colors and shapes of buds. If you cannot wait till spring to examine the bursting

of buds, bring twigs into the school-room in February and keep the ends immersed in water. The buds will burst, and may be studied at close range. Try adding some nutrient solution to the water, using the following substances: common salt, gypsum, Epsom salts, phosphate of lime, each $2\frac{1}{2}$ grains; East India saltpetre, 5 grains; ferric chloride, $\frac{1}{10}$ grain. Stir all together in half a pint of water.

"*Autumn leaves, collections, forms, tints.*"

Autumn leaves should be studied in connection with drawing and color work. When pupils have made drawings of leaves, and colored them, they will have an accurate knowledge of their forms and tints. Draw attention to conspicuous differences in forms and tints. In the case of the maples, for instance, note that the hard, or sugar maple leaf is not finely notched, and does not often turn red in the fall; that the leaf of the red (soft) maple has three lobes, is finely toothed and generally turns a brilliant red; while the leaf of the silver (soft) maple has five deep lobes and frequently turns red.

Collections of leaves may be made for reference. They must of course be pressed, and may be kept in books, either loose or pasted in.

Teachers who are interested in amateur photography may make impressions of leaves by putting them in a printing frame, and printing on solio paper in the regular way. See *Morang's Modern Nature Study*, pp. 221 and 239, for illustrations showing the forms of some of our common leaves.

"*Economic fruits, collection, forms, how stored for the winter.*"

Observe the gathering and packing of apples, pears, etc., where possible. Specimens of different kinds of

fruits should be used as models for drawing and color work. Have pupils cut shapes out of cardboard and color them, or out of colored cover paper.

"*Fruit as seed holders; dissemination of seeds.*"

Each pupil should select, early in the season, one of his own plants to be kept for seed. Select the hardiest and most vigorous plant for this purpose. Mark it by attaching a label to it stating that it is for seed. Collect these seeds and make seed packets for them of manilla paper. While the seeds are being collected, the pod will be noticed, and also the way it breaks open, if dehiscent.

If other seeds are to be collected, prepare a card of convenient size, paste on it card-board rings or squares, which will surround the seeds. While it is always desirable to label collections, very young pupils who cannot write may be familiarized with the few kinds of seeds collected without labelling them.

All this work should be related to drawing and clay modelling. It may be related, also, to number work, as the measurements required in cutting out paper or card-board for required articles, is the best kind of number work. The number of seeds placed in each receptacle, or taken by each pupil to plant, furnishes problems in arithmetic.

This correlation must not be carried on to the detriment of nature study—a quite possible result.

In collecting seeds attention will naturally be drawn to methods of dissemination. For special information see *Morang's Modern Nature Study*, pp. 237-41.

"*Roots and stems, uses, comparison of fleshy forms, how stored for winter.*"

This part of the work must be taken up in connection with the school garden. Observe the uses of roots in

providing food for the plant and in giving the plant a good hold in the soil. Show how the stem enables the plant to spread out its leaves so as to get more sunshine and moisture. Note differences between fleshy roots, such as the turnips, beets, etc. Observe methods of storing roots in pits, root-houses, etc. Note the difference between roots and underground stems like the potato, bulbs of lilies, etc. Stems bear buds but roots do not.

"*Life on the Farm:—Harvesting, primitive and modern methods compared; preparation for winter; the barn and its uses; activities of the farm during winter; winter sports and social life on the farm; the varied operations of springtime; springtime as awakening to new life.*"

This part of the course deals with elementary work, and no special directions can be given for teaching it. The teacher must rely on his own observation and general knowledge. Pictures should be made use of wherever possible.

"*Effect of sun and moisture on soil.*"

Note how moisture softens and wears away the soil, and how the sun dries and hardens it. Show that moisture and sunlight are both needed to promote growth. Observe the effects of rain and sunshine in spring and early summer.

Boys and Girls, a nature study magazine published at Ithaca, N.Y., will be found helpful to teachers in Forms I and II.

CHAPTER IV

Form II.—Animal Life—Squirrel, Crow, Etc. Insects and Insect Enemies. School Gardens, Window Plants. Study of Trees.

IN the Second Form the facts already learned about the domestic animals are supplemented and systematized. The story of *Black Beauty* gives in a very good form the life history and habits of the horse. But pupils may be encouraged, as an exercise in composition, to give the life history of the domestic animals that their parents own. Take for example a collie dog for study. How does it differ in appearance from other dogs? Is it generally found in the city or on the farm? As it grows up, what tricks may it be taught? What qualities does it possess? Is it a good hunter, retriever, watch dog, shepherd dog? What can be said of its power of scent, its courage, its speed? How has it been fed? One meal a day, in the evening, is sufficient. It should not be given much meat, but should be allowed a bone. Does it ever hide its food? Is it troubled with insects? How often should it be washed? How long does it live? What diseases is it subject to? What faults has it? Read Thompson-Seton's *Wully*, in *Wild Animals I Have Known*. What change takes place in it in its old age? The dog was probably the first animal domesticated. Why?

In connection with the study of the life history of the dog, the following quotation from *Adolescence*, by G. Stanley Hall, may be of interest:

"It appears that boys' love of, and interest in, dogs at all ages exceeds that of girls, but rises rapidly from seven to fourteen, where it appears to culminate. Girls' interest follows rather nearly the same curve. Boys' interest in cats is at all ages much inferior to that of girls, and appears to culminate at eleven, while girls' interest does not increase after eight. Boys' interest in the horse rises very rapidly in the early teens. Their interest in rabbits does not appear to increase after the eighth or ninth year, but rather to decline. Girls' interest in canaries shows an early pubescent rise. The popularity of dogs for both boys and girls at early puberty is more and more based upon their intelligence. . . The appreciation of the utility of the dog in both boys and girls rises rapidly and steadily through the early teens. Disposition to train dogs increases very rapidly from ten to fifteen. Of all the animals, the dog is the favorite; cats follow; then come birds, rabbits, horses, parrots, chickens, pigeons, squirrels, and many others. . . . . I can almost believe that if pedagogy is ever to become adequate to the needs of the soul, the time will come when animals will play a far larger educational rôle than has yet been conceived."

As the various facts regarding the animal under consideration are treated, the pupils should write them down, learning to group related ideas into sentences and paragraphs. In other words, a nature study lesson and a composition lesson may be merged into one.

The life history and habits of familiar wild animals may be observed more easily, in some cases at least, from individuals in captivity. In most cases it is almost impossible to observe the history of particular animals in their natural habitat, and all that can be done is to construct a life history from general observations.

Life History of the Chipmunk.—Born in June in the underground nest. Find one of the round "auger holes" that lead to the chipmunk's den and dig it out. Observe the chipmunk's appearance, note the

cheek pouches, the striped coat, the short tail. What kind of food can he carry in the cheek pouches? Try him with some corn, beech nuts, hickory nuts—both the bitter and the sweet. Why does the chipmunk not need a long tail? Does he ever climb trees, or jump from limb to limb? What call does he make when startled? When quiet? Do chipmunks ever play? When do they gather in their winter supplies? Where do they store them? When do they finally go into winter quarters in their underground nest? When do they come out? What are their enemies? Do they do any harm on the farm? Do they do any good?

Life History of the Black Squirrel.—For a detailed study, see *Morang's Modern Nature Study*, pp. 37-41.

Life History of the Crow.—What is a crow's nest like? In what kinds of trees do crows build? Do they build new nests every year? Look for the nests in the middle of April. Tap the tree with a stick to see if the nest is in use. The old crow will fly off if it is there. What do crows' eggs look like? If possible, find out how long it takes to hatch the eggs, and how long before the young ones leave the nest. What do crows feed on? Note the word *scare-crow*. Do crows eat meat? Why do we speak of *the carrion crow?* Is it true that they rob other birds' nests? What are some of their habits? Note their fondness for bright things. Do they fly in flocks or singly? Is it easy to get close to them with a gun? Without a gun? What are some of their enemies? Why do they attack the owls when they find them in the day time? What sort of a call do they make? Have they different calls? Are they said to live long or not? Read W. J. Long's *Crow Ways* in *Ways of Wood Folk;* and *Silverspot*, in Thompson-Seton's *Wild Animals I Have Known.*

Life History of the Cowbird.—Observe the flocks of cowbirds that return early in April. How do the males differ from the females in color? Note the distinguishing brown shade in the head of the male. As soon as the nesting season begins, look for the eggs of the cowbird in the nests of different birds, the robin, the bluebird, the song sparrow, the chipping sparrow, the yellow warbler, etc. Do you ever find the cowbird's egg in the nests of the larger birds, such as the robin? When a nest is found containing a cowbird's egg, make careful observations. Is there a full set of the smaller eggs in the nest? Examine them to see if they are sound. Sometimes the cowbird pricks holes in the other eggs to make sure that they will not hatch out. Does the cowbird's egg hatch out sooner or later than the others? Compare the young cowbird with the other fledglings as to size. He becomes so big in a short time that frequently he kills the young birds of the regular brood by crowding them out of the nest. Watch the mother sparrow or warbler feeding the overgrown cowbird. Do the smaller birds ever object to the cowbird's egg being laid in the nest? You may frequently find a chipping sparrow's nest with a false bottom or platform built in to cover up the cowbird's egg. What food does the cowbird live on? Has it any song? Can you suggest any possible good that it does? To what bird family does it belong?

At this point the pupils should become acquainted with the squirrel, chipmunk, raccoon, muskrat, woodhare, field mouse, woodchuck, bat, and perhaps the porcupine and the deer. The common birds of the district should be studied. Why go afield for nature stories regarding rare and scarce animals, when so many interesting birds and mammals are to be found close at hand?

"*Earthworm, Habits, Structure, Uses; Toad, Habits, Structure, Uses. Observations of Live Insects and their Activities, Comparison of Young and Adult.*"

As soon as the ground is turned over in the spring, the robins descend upon it to secure the earthworms and beetle larvæ exposed by the spade. This is the time to begin the study of these two animals. Why does the robin have to wait until the earth is stirred up? Does the robin manage to get earthworms where ground is not turned up? How? What brings the earthworms out of the ground? If children do not know, tell them to sprinkle a part of the lawn about six o'clock in the afternoon, and then look for earthworms. Look for them after showers. Warn pupils to approach the place of observation quietly. The ordinary footfall will cause the earthworms to draw back into the ground. Can they see? Can they hear? How do they travel? What do they eat? When familiar with the worm-holes, children will discover leaves, maple-keys, etc., pulled into them and partly eaten. Try to discover the beneficial effects of earthworms upon soil and how these effects are produced.

A consideration of the enemies of the earthworm will serve to introduce the study of the toad, and its study may be prosecuted as already outlined. *See page* 17.

As pupils advance in age, they are able to learn more about insects which they have already studied. Hence the insects mentioned in Form I, should be studied again in Form II. In this grade there should be more comparison. In addition to those insects mentioned in Form I, the pupils of Form II should become familiar with the life history of the tiger swallowtail, the cecropia emperor moth, the Isabella moth,

the potato beetle, and the tent-caterpillar. The food-plant of each should be known. All these are found in the garden or the orchard.

The method of study is as follows: Secure, if possible, the eggs of the insect, recently laid. Keep in the terrarium (see *Morang's Modern Nature Study*, p. 132) until they hatch, making a record of the changes as they occur. Provide food, preferably a small growing plant, or the leaves, if the plant is too large to transplant. Follow the development of the larvæ from day to day, recording only unusual changes. At the same time observe, if possible, the same larvæ in natural conditions. Make drawings, in color if possible, of different stages. Usually the larvæ will be obtained at a fairly advanced age. In this case, the record will begin from date of collecting the larvæ.

By the time pupils have observed all the stages in the life history of the insect, they will know the extent of the damage done or benefit conferred by it, the conditions of its healthy growth, the manner of destroying it, and perhaps something of its history in spreading from country to country. A consideration of its bird enemies will introduce the study of these birds. The study of the tent-caterpillar, for instance, will necessitate the study of the oriole and the cuckoo, as it is destroyed by these birds.

"*Plant Life.—Co-operative and individual work in the school garden; cultivation of plants in pots, with observation of the development of leaves and flowers; parts of leaves and flowers; change of flowers to fruit, and fruit to seed; functions of the parts of flowers; the forms and uses of trees; activities connected with forestry and lumbering, with study of pioneer life and present conditions on the prairie. Observation of farm, garden and household operations.*"

A pamphlet, which is a reprint from *Queen's Quarterly*, on *The Macdonald School Gardens of Canada*, or *How to Make School Gardens*, H. D. Hemenway (Doubleday, Page & Co.), will give all needed information regarding the school garden. The teacher in a rural school, however, should not worry about these well-designed, elaborate gardens. He should select a strip of land, suitable for gardening, set the pupils to work digging it up, studying soil all the time, and ask them to design plans for planting it. Perhaps the boards of trustees in rural sections will, under considerable pressure, buy an acre of land and make provision for a complete school garden. But the great majority of rural parents and trustees must be educated gradually. In almost any section, however, a teacher can secure five dollars. This will suffice to furnish a few tools, a load of manure, and some seeds. Start with these on the corner plots. Put in plants that are pretty sure to grow and to make a good appearance. Cover the approaches to outhouses with vines. Plan to improve the appearance of the school building with vines. Make window boxes and fill them with common plants, geraniums, foliage plants, sweet alyssum, nasturtiums, etc. Hold a flower show next year. With moderate success in the first venture, the teacher will get a little more money and a little more ground. By and by he will have an acre of school garden, with well-planned plots, trees and shrubbery. *The development from small to great things is of more value to a section than the immediate possession of a finished garden*, just as the earning of a hundred dollars is of more value than a gift of the same amount. With the earning develops power; with the gift comes a cringing dependence.

Whether or not a record should be kept of the planting and growth of the garden material, is in

dispute. Despite some strong assertions against keeping records, the weight of opinion is decidedly in favor of them. Some one should know the life history of economic plants if records are kept. Those who raise plants are the best authorities on their history. If we desire asters on Sept. 1st, when must we plant seeds? If we desire ripe tomatoes in August, how can we secure them? Even children in the second book classes should begin to keep records. These should be more and more exact with advancing age and increased experience. Record at least the following facts: Date of planting; date of first appearance of seedling; date of appearance of first flower bud; date of opening of flower; and, for vegetables and fruits, date of first well-formed fruit and first ripe fruit.

In connection with the cultivation of plants in pots the following suggestions contained in a paper given at the Provincial Horticultural Convention in 1904, will be found helpful:

"For window plants in winter a window facing the south or south-east is preferable, especially for flowering plants, as this aspect gives a maximum of sunshine and avoids the cold west and north-west winds. Ferns, palms, and many foliage plants will succeed as well in a window facing the north or north-east as in a south window, but flowering plants will do better in a sunny position.

"Avoid draughts of cold air on plants, as they are injurious, checking the growth, and often inducing attacks of mildew. If outside air is given plants in winter, and sometimes this is beneficial, give them ventilation on sunny, calm, and not excessively cold days. Draw the top sash of the window down an inch or two, or, if possible, induce ventilation from an adjoining room. Plants like fresh air but object strongly to being in a cold draught. A thick paper window-

blind, or sheets of newspaper between the window and plants, will protect them on extra cold nights.

"Every one who attempts to grow window plants should have a small pile of prepared potting soil made from well-rotted sod and thoroughly rotted stable or cow manure. The too common practice of using earth from the garden or black soil from the bush, is oftentimes the cause of failure and disappointment in plant growing. The earth from the garden is too often lacking in fertility, and, what is of still more importance, is too often deficient in the fibry matter found in partially rotted sod. Good potting soil may be obtained from some tough sod from an old, well-fed down or pasture field where the soil is of a loamy nature. This sod, before being used, should be stacked in the open, mixed with well-rotted stable manure or cow manure, and the pile be left to rot. Where this trouble is too great to be undertaken, prepared potting soil may be obtained from a florist.

"Use unglazed plain flower pots for growing plants. For potting rooted cuttings or slips use small pots, a two and a half or three-inch pot being usually quite large enough for potting rooted slips. When the plants are fairly well rooted, repot into a pot two sizes, or two inches larger. A change into a pot two sizes larger is usually sufficient. Over-potting, or repotting the plant into a pot four or five times larger, is a too common mistake with amateur flower growers, often resulting fatally to the plant.

"Use a mixture of one part of fine sharp sand, and three parts of the potting soil for rooted cuttings. For repotting larger plants one part of sand to six or seven parts of potting soil is about the proper proportion for most window plants. Even if common garden soil is used for potting soil, the sand will be beneficial. In potting or repotting plants, be sure that the hole in the

bottom of the pot is open to allow of free drainage. About half an inch of coarse gravel, or coal cinders, etc., should be placed in the bottom of four or five inch pots to secure good drainage. In six or seven inch pots, an inch in depth of this drainage would not be too much. Very small pots seldom require drainage.

"All freshly potted plants should be watered once as soon as potted. Give sufficient water to moisten all the soil in the pot. Do not give more water until the soil shows signs of dryness. If the plant wilts a little do not saturate the soil with water, but remove the plant to a shaded position for a few days. Too much water often kills newly potted plants, as there is no root action to absorb the excess of moisture.

"Water growing plants when they require it. To find out when plants need water, watch the surface of the soil closely. When the rough, uneven portions of the surface of the soil begin to have a light, greyish color, or when the top of the soil will crumble between the thumb and finger, the plant requires water. Give sufficient water to moisten the soil to the bottom. Plants should be watered only when the soil requires the moisture, which condition can only be learned by experience and observation. The diary or calendar is of no use as a guide in the watering of plants. One rule should always be borne in mind, viz.: that sufficient water should always be given growing plants to moisten, not saturate, all the soil in the pot. Light sprinklings of water that only penetrate through an inch or so of the soil are useless.

"In winter use tepid or rain water, at a temperature of about 65 degrees. In spite of assertions to the contrary I am satisfied that water of a temperature at or near freezing point is injurious to plant life in greenhouses, to say nothing of window plants."

The analysis of leaves and flowers must not be

detailed nor scientific in this, or, indeed, in any public school grade. The blade, petiole, and veining of the leaf, are sufficient. Let pupils express themselves in drawings and in models. The different sets of floral leaves may be noted, and designated as first, second, third and fourth, respectively. Any function of these leaves that pupils *discover* for themselves should be recorded, but unless discovered, the functions may well be left for higher classes. Pupils should discover, under the teacher's direction, that it is the fourth or central set of floral leaves that develops into the fruit. They should observe what becomes of the rest of the flower. Second book classes need not know that the pollen must fall upon the stigma to develop fruit. Confine their attention to the outward conditions of securing good fruit or perfect flowers.

"*Forms and uses of trees.*"

The common uses of trees will readily suggest themselves, and a study of their uses will lead to a study of their forms. The most obvious use of trees is to supply firewood. What kinds of trees make the best firewood, and why? Some kinds of trees are used for building material, the pine for instance. Does it make good firewood? Why is it good for house building? What kinds of trees are used for shade in the city? In the country? Why does the elm not make a good city shade tree? How do fruit trees differ from ordinary shade trees in size and shape? Compare the apple with the maple, for instance. What kinds of trees are required for telegraph and telephone poles? Consider the question of height, weight, durability, etc.

After a heavy rain, or after the snow melts in the spring, which part of the ground dries up most quickly, that in the open, or under the trees? Show how the trees help to keep the ground moist. Besides giving

shade, trees are sometimes planted for protection from the wind. What kind of trees make the best protection in winter? In summer? Compare the winds on the prairie with the winds in the wooded parts of the country.

Besides their use to man, of what use are the trees to animals and birds? Note the evergreens as places of shelter for birds in winter. What trees supply food to the squirrels, raccoons, porcupines, etc.?

Pictures of different kinds of trees may be readily obtained from newspapers and magazines. A set of twenty-four pictures of our common trees is published by A. W. Mumford, Chicago.

Forestry, lumbering and pioneer life are best presented by a series of good pictures, except that native trees, both in the open and in forests, can be observed within easy reach of any school. Compare the form of trees in the open with the same in a forest. Consider which is better for lumber, which for fruit, which for beauty.

Observations of farm and household operations are to be made whenever occasion calls for the need of special attention to them.

If pupils have garden plots at school or at home, they will be interested in the weather reports of frost, rain, etc. Weather records should be kept, so that in years to come pupils may have a definite idea of the latest and earliest frosts, of the relation between winds and cool weather; of the effect of bodies of water on temperature of the air, etc. Refer to the weather bulletins in the newspapers.

CHAPTER V

Form III.—Animal Life—Adaptation of Animals to Surroundings, Aquaria, Trees, Soil, Weather

THE pupils have now reached a stage when they are beginning to consider the relation of means to end, and hence the study of adaptation is important. In the case of the domestic animals this will give us no difficulty. The adaptation of the cat, for instance, for hunting at night, and for noiseless and rapid movement, may be readily seen; and similarly with other animals, the adaptation of the sheep for rocky pastures, of the horse for travel, of the duck for water, etc.

In the case of the wild animals, one or two salient points in each case will perhaps be sufficient. Note how the teeth of all the rodents are adapted to vegetable food, and those of the carnivora to animal food. Note the use of the tail in animals that climb from tree to tree, such as the raccoon and the squirrels, or in animals that live in the water, such as the musk-rat. Compare with the wood-hare, where the "cotton tail" is of service only as a guide to the young hares in the darkness, and with the porcupine, where it is a means of self-defence. Note the length and strength of the legs of the wood-hare, raccoon, etc. How are these animals adapted to outwit their enemies? In color, note the contrast between the wood-hare and the skunk in white markings, and explain. In speed, contrast the wood-hare again with the woodchuck. In power of scent, contrast the woodchuck with the fox. Does keenness of scent depend in any way on the kind of food that each requires?

In the case of birds the key to adaptation lies in the study of their food. Note the following classes:

1. *The Owls.*—Good sight and silence are necessary. Hence the large eyes, and the thick feathers adapted to noiseless flight.

2. *The Hawks.*—Speed is the important thing. Note the length and strength of wing and the absence of needless feathers.

3. *Sparrows and Other Seed-eaters.*—Note the hard conical bill and the horny tongue.

4. *Woodpeckers.*—Observe the position of the toes, the long, strong bill, the very long, barbed tongue, the stiff tail feathers serving as a prop. Compare with the sapsucker, whose tongue is provided with a brush instead of a barbed tip.

5. *Flycatchers.*—Note the hooked bill, and the hairs at the base of the bill, which help to entangle the moth or fly.

6. *Swallows, Swifts, etc., that catch food with the open mouth.*—Note the large mouth, insignificant bill, long wings and tail.

7. *Cuckoos.*—Live principally upon caterpillars. Hence the long bill. The stomach of the cuckoo is lined with hair.

8. *Kingfishers.*—Contrast with the swallows. See frontispiece of *Morang's Modern Nature Study.* Note the heavy bill, and the stout body adapted for diving rather than for rapid flight.

9. *Humming-birds*—Have a long tubular tongue for sucking up the nectar from flowers. The long bill enables the humming-bird to reach the insects which it finds in the flowers.

10. *Robins, Bluebirds, Thrushes, Wrens, etc.*—Note the soft bills, as these birds live principally on worms, beetles, etc.

11. *Kinglets, Chickadees, Creepers, etc.*—The small, sharp bills are useful in probing small crevices.

12. *The Water Birds.*—Observe the longer neck, and the adaptation of feet and legs for wading, swimming, diving, etc.

Closely related to the study of adaptation in form, is the observation of protective coloration in bird and animal as well as in insect life, and the relation of the food of birds and animals to their habits, migrations, etc. These points should be noted by the class when the opportunity presents itself.

"*Birds—Life-history of Types.*"

The order in which types are studied must depend upon local conditions. In general, begin with the best-known families, and take as types the birds that are most common in the district or most important from an economic point of view.

The sparrow is a good family to begin with, and the English sparrow and the song-sparrow may be taken as types. In northern Canada the white-throated sparrow may be studied instead of the English sparrow. Watch the English sparrows building in the spring. Where do they build? Do they ever build in trees? The writers once found an English sparrow nesting in an old oriole's nest, which had been lined with feathers for the occasion. Procure a nest and examine it. Note the eggs, number, size, color. Watch how often in the season the sparrows build. Watch the old sparrows teaching the young to fly, to get food, etc. What do the English sparrows live on? Examine the bill to see what kind of food it is adapted for. Throw out some grain and other kinds of food. How do the English sparrows treat each other? How do they treat other birds? What other birds do they keep from nesting about the house

or barn? Do they stay all the year round? Where do they go for shelter on cold nights? Have they any song? They may be kept from increasing by shooting them off, by feeding them with grain soaked in arsenic in the winter time, or by destroying their nests. If a nest is desired for observation, put up a bird box in the vicinity of the school.

Compare with the song sparrow as to migration, time of nesting, nesting-place, nest, number and color of eggs, song, food, enemies, and appearance, including form and markings.

Some of the commoner birds which may be studied as types are, the screech owl, the sharp-shinned hawk, the bronzed grackle and the oriole, the robin and the bluebird, the house wren, the blue jay, the yellow warbler, the downy woodpecker, and the chickadee. For a detailed study of the kingbird, see *Morang's Modern Nature Study*, pp. 79-83.

"*Habits of Wild Fowl in different seasons.*"

Except in a few favored localities it is difficult to make any study of water birds and game birds from direct observation. The migrations of the wild fowl should be noted and attention should be directed to the game laws. Interesting studies of the habits of certain of the wild fowl will be found in Long's *Wilderness Ways*, *Secrets of the Woods*, etc., and in Thompson-Seton's works.

"*Fish, forms and uses of different parts of the body, food and how obtained.*"

No school is properly equipped for nature study without an aquarium. There is so much life in the ponds, lakes and rivers of our country that we can never gain a knowledge of it without an aquarium in the school-room. The cheapest aquarium is the

square candy bottle, with wide mouth. Several of these are better than one large aquarium, as many water animals prey upon smaller ones and they cannot be kept together in the same compartment. These small bottles should be supplied with a few stones, shells and clean sand to the depth of an inch or so. Then collect the small plants that grow in stagnant ponds, chara, mare's tail, anacharis, duck weed (floating), and place a few in each bottle. These plants will keep the water pure, and this is a most important lesson in balance in nature. According to the mental ability of the pupils, this balance between plant and animal life in an aquarium opens up extensive fields of a semi-scientific investigation.

In order to keep the sides of the aquarium clean, a few water snails and tadpoles, obtained from stagnant pools, should be kept in each aquarium. Water can be kept for months in such a simple aquarium without becoming putrid. All that is necessary is to add more water as evaporation takes place. Dust can be kept out by keeping linen gauze over the top of the bottle.

Small fish, especially minnows, can be kept in these aquaria with tadpoles and snails, but in a half-gallon jar it is better to keep only one or two fish and some snails, while the tadpoles may be kept in another jar. If running water can be provided, large fish may be kept. See *Hodge's Nature Study and Life*, Chap. xxiv; *Morang's Modern Nature Study*, pp. 94-103.

"*Life histories of moths, butterflies, beetles and grasshoppers; useful insects, as ladybird and dragonfly; harmful insects, nature's insecticides.*"

When nature study is first being introduced, and where no previous work has been done, the moths and

butterflies already mentioned under Forms I and II, will have to be studied here. Those species are usually common enough to be obtainable anywhere. In addition, there are the "woolly-bear" larvæ, and the injurious moths whose larvæ are so destructive of shade trees, *e.g.*, tussock moths, web-worms, and canker-worms. To include these under some general head, begin with a study of the apple tree for a third class, and a maple tree for a fourth class. Observe the natural leaves, twigs and fruit, so that any abnormal state may be detected at once. Make drawings of twigs, leaves and fruit, also of the whole tree. Some of these drawings should be done in color. Model the fruit and leaves in clay. Preserve specimens of leaves and, in the case of the maple, cross-sections of small limbs, showing the nature of healthy bark and wood. If the normal leaves, twigs and fruits are first considered, it will not be long before some abnormal condition will be discovered. Some leaves will be found partly eaten. Look for the insect larvæ that ate the leaves. Some twigs and branches will be found covered with the oyster-shell bark-louse. Study these. Holes will be found in the bark. Look for borers. Fruit will be wormy. Open such fruits and in some of them will be found full-grown larvæ of the codling moth. Keep the larvæ in boxes, along with bits of bark, until they form cocoons. Continue their study so as to learn the whole history of this most destructive pest and the best way of combating it. The following is a list of pests that attack some part of the apple tree. See Bulletin No. 144, Apple Culture, Ontario Department of Agriculture.

Roots.—Woolly aphis.

Trunk.—Round-headed borer; flat-headed borer; Buffalo tree hopper; oyster-shell scale; San José scale.

Buds and Leaves.—Bud moth; fall canker-worm; spring canker-worm; tent caterpillar; cigar-case bearer; pistol-case bearer; apple plant lice; buccalatrix moth; leaf rollers; leaf miners; red-humped caterpillar and yellow-necked caterpillar.

Fruit.—Codling moth larvæ; apple maggot; curculio.

Fungus Diseases of the Apple.—Apple scab; bitter rot; black rot; fly-speck fungus; fruitspot; powdery mildew; apple rust; crown gall; fire blight.

Treatment for all these diseases is described in Bulletin No. 144. Most of these should be left for fourth classes.

The prickly pupa-cases of certain ladybird beetles will be found on the apple trees. The larvæ of these beetles may be found feeding upon the plant lice. No other insect is so generally beneficial as the ladybird beetle, and there are many species. So common and useful a creature should be studied assiduously.

The grasshoppers afford interesting material for study. We constantly hear the common grasshopper grinding out its rasping love-song, yet we seldom try to discover its musical instruments, the wings and legs. Begin here. In a terrarium or in a small glass bottle, its movements may be observed. When we know that the sound is produced by so simple a mechanism, we shall be interested in examining the wings and legs. Its destruction of grains and grasses should arouse interest in its mouth parts and internal anatomy. Its food and the destruction which this insect causes should be discovered, and its whole life history should be worked out as has been done with other insects.

As before stated, an aquarium is an essential part of equipment in nature study. As it is an imitation of a stagnant pool, you should go to such a pool for the animal and plant life required. Scrape up the mud or ooze from the bottom of the pool in your sieve, (an old tin dish with holes punched in the bottom

with a nail will answer this purpose). With this ooze you are pretty sure to bring up at some time a grasshopper-like animal, which, however, differs from a grasshopper in its general proportions. The fact that it is found in water proves that it is not a grasshopper, for by this time pupils should have discovered that the young grasshoppers are born in soil, not in water. Such a specimen is almost sure to be the larva of some species of dragon-fly. Its habits in the aquarium will form interesting nature work.

If found in the spring, look for the emergence of the adult in July or August. If found in the fall, it will not emerge till next year, and it may be observed all winter. The aquarium must be supplied with some small reeds or sticks which project above the water, so that when the presentiment of impending change comes upon the larva, it will find a support up which to climb to its future medium, the air. After the class have observed the emergence of the adult dragon-fly, they will be interested in the description of the process as seen by the Water Baby, Tom, in Kingsley's *Water Babies.*

It is interesting to put these dragon-fly larvæ in with mosquito larvæ, and observe what happens. Put fish in with mosquito larvæ. The extermination of the mosquito is worthy of our most serious attention. If we can in any way call to our aid such voracious feeders as fish and dragon-fly larvæ, let us do so.

The adult dragon-fly is no less active in the air-pool than the larva is in the water-pool. Its peculiar flight is due to its darting after small insects. It is an excellent insect for permanent mounting by the method described in *Morang's Modern Nature Study*, p. 324. Children should be taught not only that it is perfectly harmless, but also that it is one of our most useful insects, as it preys upon harmful species.

Nearly every animal preys upon some other animal. The exceptions to this are the graminivorous animals, such as the cow, sheep, horse. When the life of a region is unbalanced so that some particular animal gains the ascendency and drives out all others, nature has been violated. The disproportionate increase of insects destructive to gardens and orchards, in the last few years, is due to the decrease of birds that prey upon insects and their eggs. The relation of birds to insects should be made an important part of nature study. One summer a bluebird built its nest in a hole in an old apple tree at the corner of a house in which lived a family of seven boys. The bluebirds raised their family almost within reach of a tall boy standing on the ground, yet not one egg or bird was molested. In fact, the orchard on this farm was well stocked with birds' nests, one tree having three nests in it. The boys knew the value of birds to the orchard, and would resent any one's interference with them. Birds are nature's most important insecticides.

Nearly every insect larva is in danger of being made a nursery for the rearing of the young of some other insect. It is not unusual to find a tomato worm covered with the cocoons of a parasitic insect, which lays its eggs in the body of the tomato worm. The common parasite in this case is an ichneumon fly. The egg-laying apparatus of the female fly is remarkable. The larvæ of the tussock moth and other hairy larvæ are subject to the attack of a small ichneumon fly (*Pimpla inquisitor*). The study of these destroyers of harmful insects is a revelation.

The borers are good types of beetles, but other beetles are more easily obtainable. The larvæ of the May beetle are frequently turned up in digging the garden, and among rotting wood the larvæ of

several beetles may be secured. These may be kept till transformation into pupæ, and finally into beetles, occurs. The life history of the borer beetles is so difficult as to be beyond ordinary observation. Read about them.

It is well to remember that the peach borer, the maple borer (*Synanthedon acerni*), and many other borers like these, are larvæ of clear-winged moths, quite unlike beetles. For third and fourth book classes, the maple borer is an excellent subject of study. Where these insects are numerous, the trunks of soft maples have the appearance of having been riddled with bird shot. From some of these openings the pupa-case of the moth protrudes throughout the year, but it is at the end of May or beginning of June that the adults may be found emerging from their pupa-cases. They are easily captured from 7 to 9 a.m., as they are then drying their wings before beginning to fly. The peach borer larva is readily found by cutting through the bark of the peach tree wherever gum is exuding from the tree. In fact, this is the way to exterminate the peach borer, as the wound in the tree soon heals.

Plant Life.—"*Germination of seeds under controllable conditions and in the school garden and window boxes.*"

The remarks made under Form II will apply here.

"*Opening of buds.*"

This has already been referred to under Form I.

"*Study of the forms and functions of the parts of plants, and comparison of these forms and functions in different plants.*"

This work may be begun in this form, but should be carried on more extensively in Forms IV and V.

Select a few plants which have large and easily observable parts. In September study the yellow evening primrose or the nasturtium; in October, the bottle gentian or the pansy; in November, the late asters, which have survived the frosts. In March, begin with the pussy-willow; in April, study any common flower, *e.g.*, hepatica, or tulip; in May, lilies or spring beauty; in June, wild columbine, or lady's slipper. Make drawings in color of the flower selected, then use the flower or some part of it as a unit of design, and apply to some surface for purposes of decoration.

Aim to discover what plants do, how and where they grow, how they propagate, and how they survive in the struggle for existence. Each species of plant prefers a certain habitat. Find what this habitat is. Classify plants according to their habitat, *i.e.*, plants that grow in woods, in swamps, in water, in sandy soil, in waste places, etc. It is much more important to know how to grow plants than to know all their Latin names and the technical terms used by botanists. See Appendix to *Morang's Modern Nature Study.*

"*Observation of the culture of farm and garden crops, and of orchard and shade trees.*"

In rural schools the culture of farm and garden crops may be observed on adjacent farms, but, even there, and in city schools, it is desirable to plant in school plots the seeds of the plants which must be observed. It would be absurd to attempt to observe every crop each year. From the numerous grains select one for the year's work, *e.g.*, corn. In garden crops specialize one year on tomatoes, raising plants from seed; another year on sugar beet, or celery, etc. One or two species well grown are better than many crowded together and poorly attended to. The benefits of mixed farming and gardening must be kept

in mind, however, and the need of rotation of crops, of properly enriching the soil, and of keeping down weeds, should be practically demonstrated. Take some good garden periodical, such as the *Canadian Horticulturist* (Toronto, Ont.) or the *Garden Magazine* (Doubleday, Page & Co., New York). *The Canadian Garden*, by Annie L. Jack (Wm. Briggs, Toronto), gives all needed information for Canadian gardeners. Any one can learn to be a gardener by starting in to make a garden and then reading the proper books to secure information.

Observation of orchard and shade trees should be taken up systematically as suggested in the study of the apple tree. Here, as in the case of grains and garden crops, make a selection of one for each year's study. If one tree is being studied intensively, most of the other orchard trees will come up incidentally for observation. The study of the codling moth in the apple will bring up the question of what other fruits it attacks. Examine pears, plums, peaches and quinces, for the larvæ. While this is being done, the work of the plum curculio will be discovered, and its life history should be studied.

It is quite worth while to raise apple, pear, peach and plum trees from seed; to graft or bud them, to learn how to cut back and to prune, and how to secure more perfect fruit. See Bulletin No. 124, Ontario Department of Agriculture.

"*The observing and the distinguishing of the common forest trees.*"

Here again local conditions must largely determine the order of study. Trees that are in the immediate neighborhood of the school, or that may be readily observed by the pupils, should be first considered. In northern Ontario, for instance, the evergreen and

the birch will come in for consideration at the outset, while in most parts of southern Ontario the common hardwood trees, maple, elm, beech, etc., will be first observed.

The study of trees may be carried on both in winter and summer. In winter we should learn to distinguish trees by their general shape, the character of their branching, the bark, etc. In summer they may be distinguished by their buds, flowers and leaves.

Let us, for illustration, begin with the winter, and let us suppose in the first place that evergreen trees are common in the neighborhood of the school. Of the evergreens the pine is the most prominent, and the two common species, the white and the red, should be distinguished. General appearance will be a sufficient guide in this case, for the red or Norway pine is shorter, thicker, and redder in appearance than the white. But if any doubt exists in the mind of the beginner, an examination of the needles will settle the question, for those of the red pine grow in pairs, while those of the white grow in bunches of five. Most pupils are familiar with the spruce, both the imported and the native varieties, for it is the common evergreen of our lawns and gardens. But another tree which is very common in northern Canada and which looks very much like the spruce, is the balsam fir. The fragrance of the balsam should be a distinguishing mark, and it will be observed, in addition, that its needles are shorter and blunter than those of the spruce and grow in two rows from the stem, while those of the spruce cover the stem on all sides. Another common evergreen is the hemlock, which has short blunt needles and small cones, but which grows tall and dense like the white pine. The bark of the hemlock is used for tanning leather. Another member of the pine family is the larch or tamarac, which grows

in swamps, but it cannot be described as an evergreen, as it loses its needles every fall.

The same kind of soil that is favorable to the evergreen generally produces the birch, and the three common varieties, the white or canoe birch, the yellow, and the black, may be readily distinguished by their color.

In parts of the country where the evergreens and birch are not common, the hardwood trees come in for observation. The American elm is our most conspicuous hardwood tree, and is the best one to begin with. Note the different forms—the parasol, the umbrella, and the fountain shaped varieties. Compare the trunk with that of the spruce. In which case does the trunk run in an unbroken line from the top to the bottom of the tree? Note the drooping elm as a favorite place for orioles' nests. Next study the maple. Note that the sugar maple is larger and more rugged than the two common varieties of soft maple. Compare the branches with those of the elm as to size. The beech is also an excellent tree for study. Note the smooth bark, the irregular branches and the dense rounded crown. What animals are attracted by the beechnuts in the fall? After the elm, maple and beech have been studied, continue with the willow, poplar, oak, ash, basswood or linden, buttonwood, chestnut, and other varieties.

In the summer the study of the leaves will assist in the identification of the trees. Note the character of the leaves, whether smooth or hairy, notched or unbroken, opposite or alternate, simple or compound; and observe also the character of the seed, whether carried by the wind or planted by other agencies such as animals and birds. The study of trees may easily be carried on in connection with the study of birds and mammals.

Direct the attention of the pupils to the branching of trees, and note the difference between trees growing in the open and those growing in the woods. In the latter case the lower branches, not getting much light, drop off and the trunk of the tree grows taller and is free from knots. Pupils will readily see which tree makes the best timber. The increasing value of wood for manufacturing purposes should be sufficient incentive to turn our attention to the successful treatment of forests. The need is very pressing.

"*Different kinds of soil, as sand, gravel, loam, leaf mould and clay; experiments to ascertain how soils are composed, whether of mineral or of decayed organic material, and which best retains water.*"

From some spot in or near the school-yard, cut out a piece of sod as wide as a spade and as deep as can be kept together. Transfer this to the school-room and place in the terrarium, or in any suitable place. If necessary, dig out more of the soil from the same hole and bring it in for observation. If an excavation for a building is being made near the school, or if a bank is being cut through along the road, the different layers may be observed. There will be at least three layers of soil, but there may be several. The top will be the darkest, several inches deep; then a second layer not so dark, and a third layer entirely lacking in any black substance. Layers of sand or gravel may be found in certain localities. Feel each kind of soil. Select some of the first layer, dry thoroughly, and weigh out half a pound. Place on a clean shovel, and lay the shovel on hot coals for an hour or more. Tell what happens. Weigh the residue. What has been burned out? What remains? Do the same with the second and third layers, and with pure sand and pure clay. As pupils

know that vegetable and animal matter burns, they will conclude that loss in weight is due to burning out these ingredients. The burned-out material is the food part; the residue, the mineral part.

As clay modelling and sand moulding are necessary in the ordinary school work, the character of clay and sand will be learned incidentally. It will be discovered that clay holds water longer than sand; that the clay hardens as it dries, while sand disintegrates; and if some one can be found who owns a kiln for burning china, the value of clay in making flower-pots, etc., may be demonstrated.

Cut the bottoms off half a dozen bottles, place in them gravel, sand, loam, leaf-mould, leaves and poor loamy soil, an equal weight in each. Cork with a notched cork and invert in a rack prepared for the bottles. Pour an equal volume of water on each and measure the water that drips through in each case. Compare each material in absorbing power.

Any soil may be analyzed roughly by mixing it in water and decanting the upper part. The coarse gravel will settle at first, then fine gravel, then sand, then clay, and lastly humus. Observe how every stream carries down and deposits these constituents. Explain why they are deposited as they are.

"*How nature prepares the soil for growth of plants. Additional phenomena of spring in the vicinity of the school, cause of snow melting, ice floating, etc.*"

In spring, the effects of the winter's frost on soil may be seen. Land that was ploughed in the fall, and that was lumpy and hard, will now be well pulverized. The school garden will furnish an example. If rocks are in the vicinity of the school, examine them to find cracks due to frosts. As banks by streams or lakes thaw out, great masses tumble down. Later the

spring rains cause huge landslides on steep hillsides. Sometimes these may dam the stream and change its course. Use these phenomena to give pupils a conception of world-building in general.

The melting of snow should be taken up in connection with the study of the thermometer. The temperature of melting snow or ice is constant. This fact should be discovered by inserting the bulb of a thermometer in melting ice. The mercury will fall to a certain point, at which it will remain stationary. Steam from boiling water, under standard conditions, is also of constant temperature. This fact should be discovered by suspending a thermometer in steam in an enclosed space, just above boiling water. The mercury will rise until it reaches a certain point, at which it will remain stationary as long as the bulb and stem are surrounded by steam. Pupils should find these points by actual experiment and mark them by tying a small thread around the stem of the thermometer. The distance between the two points may then be marked on a piece of cardboard and divided into 100 or 180 equal parts. The former gives the centigrade scale; the latter, the Fahrenheit. The divisions may be continued above and below these two fixed points. On the centigrade thermometer the freezing point is called zero and marked O°. Fahrenheit chose to call a point 32 degrees below freezing point zero, so that freezing point reads 32° above zero. On the centigrade thermometer the temperature of steam from boiling water is called 100°, while on Fahrenheit's it is 212° (32°+180°). If the space between the position of the mercury in melting snow and its position in steam were divided into 80 equal parts, as it is in Reaumur's thermometer, then boiling point would be just 80° degrees above freezing. The fewer divisions this distance is divided into, the larger

are the degrees. Thus in Reaumur, each degree is $\frac{1}{80}$; in centigrade $\frac{1}{100}$ and in Fahrenheit $\frac{1}{180}$ of the difference between freezing point and boiling point.

It is a peculiar thing that the temperature of melting ice is the same as that of water which is just freezing or changing into ice. The difference between the two is that when ice is melting, heat must be added all the time, but when water is freezing, heat is being taken away from the water. Whatever heat may be required to melt a given weight of ice can be recovered from the water produced by converting it into ice. Hence, water while cooling to freezing point, and while freezing, gives off heat, which tends to moderate the climate near by.

Ice.—Observation proves that water expands when it freezes, that is, is of greater size than the water frozen to form the ice. The weight remains the same. When ice melts it produces a volume of water less than its own size. Cut out a rectangular piece of ice, measure, melt it, and measure the water formed. Cut several rectangular pieces of ice of different sizes. Float them in water. In the case of each piece, measure the proportion immersed. Compare the proportions in each case. Float a piece of ice in water in a glass vessel, marking the level of the water in which the ice is floating. After the ice has melted, note the level again. Is it the same, higher, or lower? Explain. From the foregoing experiments the pupils will be able to understand the nature of icebergs. It is important, too, that pupils recognize that ice below melting point acts like any other solid, *i.e.*, expands when heated and contracts when cooled. This will explain how masses of ice like glaciers move down an incline. As they become warmer during the day, they expand, mostly down hill; as they contract at night, the contraction draws the whole ice-sheet more down than

up, since it moves more easily in the downward direction. Observe the effects of frost on soil, rocks, clover, posts, etc.

Water.—Secure some rain water and some well water or good spring water. Note how hard soap affects each kind of water. One kind dissolves the soap, and, if agitated, forms a "lather." The other becomes "curdy," and more or less milky and does not form a "lather" readily. The former is called soft water, the latter hard water. Keep adding soap to the hard water. Eventually it will form a fair lather, if agitated, because all the lime in it has been thrown out by the soap. Put washing soda in hard water, then add soap, and agitate. Put ammonia into another portion of hard water, then add soap. Boil hard water and test its hardness afterwards. Teach pupils the test for limestone by placing some limestone in hydrochloric acid in a test tube. Test with hydrochloric acid the substance found in tea kettles, after they have been used some time. Strong vinegar may be used instead of hydrochloric acid.

Make some lime water by pouring water on hard, fresh, unslaked lime. Let it stand for half an hour or so. Observe the changes that occur in the process known as slaking. When the lime has been thoroughly slaked, mix it with water, shake well, then let it stand until clear. Pour off the clear liquid. Add more water, shake again, settle, and pour off as before. The liquid poured off is lime water. Keep it in a bottle, tightly corked.

Blow air from the lungs through some lime water in a glass vessel. Try to collect some of the white substance formed, after it has settled to the bottom.*

*A solid formed in this way is called a precipitate. It can be separated from the fluid in which it is suspended by passing the same through clean white blotting paper, folded into a cone shape. Paper specially prepared for this purpose is called filter paper.

Test this white substance with hydrochloric acid or strong vinegar. Compare with limestone.

Blow air from the lungs through another portion of lime water, but this time continue for ten minutes, noting the changes that occur. If it becomes clearer after a time, this proves that the white substance formed at first has dissolved in the water again. Let the white substance that remains settle to the bottom. Pour off some of the clear liquid and boil it. If it becomes milky, this shows that the dissolved substance has been thrown out again. Compare this result with the result of boiling hard water in a tea kettle. In Form IV, infer that rain water passing through limestone rocks dissolves some of the limestone. When such water is boiled the limestone remains as a solid residue. If water trickles through crevices in rocks and evaporates, a solid residue of limestone is formed. In this way stalactites and stalagmites are formed in caves.

"Pure and impure water."

Water that is not clear contains small solid particles in suspension, and is impure. Such solid impurities can be removed by filtering. Make a filter as follows: Place some gravel in the bottom of a vessel provided with a tap; on top of this place some clean sand, then a layer of crushed charcoal, then more sand. The charcoal may be omitted if sufficient layers of gravel and sand are used. Filters must be cleaned frequently. This is done by removing the old substances entirely and putting in new.

Water may, however, be clear and even sparkling, and yet be very impure. If it has any marked odor or taste it should be considered unfit for use. But some substances have neither odor nor taste and yet are injurious. The presence of ammonia in water indicates that organic impurities are present. Nessler's

solution for testing ammonia may be purchased at drug stores. This solution gives a brownish precipitate if free ammonia is present. Potassium permanganate is a convenient and cheap test for impurities in water. Dissolve a few crystals in water. Add a few drops of this solution to the water to be tested, sufficient to make it quite pink. Place in a clean vessel in a warm place and keep free from dust. The best kind of protection from dust is a stopper of cotton batting or a cover of fine muslin. If the water is impure the pink color of the potassium permanganate will be bleached out in an hour or two, a sediment forming at the bottom.

The presence of mineral substance in solution in water may be proven by evaporation. (Use a clean glass vessel for evaporation.) If any mineral substance is present, a "crust" will remain when the water has been all evaporated. It is impossible in elementary work to determine what this mineral substance is, but chlorides may be tested for by using silver nitrate. A drop or two will give a dense, white, curdy precipitate, soluble in ammonia.

"*Sources of heat, expansion of solids, liquids and gases, by heat; practical applications. Temperature; thermometer, construction and graduation. Methods of transmission of heat, conduction, convection and radiation; causes of winds and ocean currents; ventilation.*"

Any elementary work on physical science will give all needed information on these subjects.

It is not advisable to make your own thermometer. Detach a thermometer bulb and stem from its scale and use it for experiments described. The tube must be long enough to indicate the boiling point.

Health experts now claim that each person in a room should be supplied with 30 cubic feet of fresh air per

minute. This requires 72,000 cubic feet per hour for 40 pupils. An ordinary school-room contains about 10,000 cubic feet of air. Hence the air in a school-room should be changed seven times per hour if 40 pupils are in a room of 10,000 cubic feet capacity. The regulations of the Ontario Education Department require that the air be changed only three times per hour. The mean between these, five times an hour, should be the minimum. According to this the air in a room should be changed in twelve minutes. To learn if this is being accomplished, charge the air in the room with smoke when pupils are absent, closing all inlets and outlets. Open inlets and outlets and see how long it takes to get the room clear of smoke. Or the rate at which air is passing out of the foul air shaft may be estimated approximately. Thus when air can be felt to move by the fingers, it is moving about 2½ miles per hour. The effect on a candle flame may be used to judge the speed of the air. Carry a candle across a room at the rate of 3 miles an hour (22 feet in 5 secs.); four miles an hour, etc. Observe effect on flame, and then place candle near the foul air exit. Measure the size of the opening and calculate the volume of air that flows out each hour.

Weather records are valuable to students, especially in geography. These records should indicate the temperature, the direction of wind, its velocity, the character of the clouds; if near the weather observatory, the minimum and maximum temperatures as obtained from weather reports each day should be recorded. A column should be kept for remarks in which records of such phenomena as rain, snow, fog, frost, etc., may be entered. If the school is supplied with a barometer, a column should be made for its readings. Barometer readings may be obtained from weather reports in daily papers.

Date	Noon Temp.	Wind		Clouds	Weather Report		Barom-eter	Remarks
		Direct'n	Speed		Min.	Max.		
Oct.17	54°	East	Strong	Rain clouds	39°	54°	29.95	Showery

After these records have been kept for a month or two, pupils will be able to generalize thus: Southerly winds bring warm weather; northerly winds bring cool weather; easterly winds cause rainy weather, cooler than south or west winds; west winds are most common and most pleasant, not causing such great changes in temperature as other winds.

With these facts before them, pupils learn that the part of the earth south of us is warmer than ours; the part north is colder; the part east and west about the same. They are then ready to learn how latitude affects climate, and that places east or west of each other are generally of about the same temperature.

Records should be made of the phases of the moon, new moon and its position, full moon and its position, and the time of rising and setting, obtained from *The Canadian Almanac*. The position and movements of the planets should be followed, at least so as to know evening and morning stars.

Each day at noon the angle made by the sun with the horizon should be measured by using a protractor. Pupils will then learn the relation of the sun to the seasons, and will know (what few entrance pupils in this country know), that the shadow cast by the sun in our latitude is always to the north. Devise a plan for measuring the height of trees by the length of their shadows.

A sun dial may be made by drawing a large half-circle and dividing it into angles of from one to five degrees, according as accurate results are desired. Locate noon by the shortest shadow of a stick set (in

a perpendicular position) at the centre of the half-circle. Or a compass may be used to find when the shadow falls due north. But compass needles point to the magnetic north, not to the north pole or star, and the variation changes from year to year and is different at different longitudes. Consequently the line of the shortest shadow, or a line pointing to the north star, is the true noon line. When this line has been found, each quarter of the circle may be divided into six equal parts to indicate the hours from six a.m. to twelve, and from twelve to six p.m. Pupils will observe that noon by the sun is not twelve o'clock standard time. Except on the seventy-fifth meridian it is more or less after twelve o'clock standard time, according as the point where observations are made is distant from this meridian. Each degree west will make standard time four minutes faster than sun time. At 85° long. W., noon by the sun would be forty minutes after twelve by standard time.

In fourth classes the nature of standard time should be thoroughly studied. The reason for its adoption should be discovered. This will open up the whole question of time, and pupils will be interested to know that news may be received in Toronto from London, Eng., several hours before the hour at which they are reported to have happened in the latter place.

The observation of constellations from month to month will give children a concrete idea of the movement of the earth in its orbit. Most of us know by hearsay that the world moves through space, but we cannot tell how this may be observed. Just as in a boat, by keeping the eye on a fixed object on shore, we can tell how the boat is moving, so by noting the position of the fixed stars in the celestial sphere so well mapped out in constellations, we may be conscious of the earth's movement in its orbit through space.

All study of stars and planets must begin with the north star, which may be found from the position of the big dipper (in Ursa Major). The circumpolar stars are always visible, the only change being the position of the constellations as the earth revolves about its axis and in its orbit. Draw a map of the stars as they appear at 9 p.m. on a certain date, *e.g.*, Oct. 20th and Feb. 4th.

From the plan of the heavens (see Comstock's *Text-Book of Astronomy*. D. Appleton & Co.) a star map may be constructed by keeping in mind that north, from the north star, is downwards towards the horizon, and that south is upwards, over the vault of the heavens. If then we make the top of our page stand for the north, as in ordinary maps, our plan must be turned upside down. All stars east of the polar star are then on the left, so that the right side of the paper is the west side of our map; the left side, the east.

CHAPTER VI

Form IV.—Animal Life.—Relation of Fish, Birds and Wild Animals to Man; Life Histories of Conspicuous and Economic Insects. Trees, Minerals and Soil.

BY the time pupils have reached this grade under the present course of study, they will be familiar with common fish, birds, and wild animals so as to recognize them at sight. They will also know their life history more or less accurately. In this grade we pay more attention to relations than in any former grade. It is not beyond these pupils to discover that the fins of fish, the wings and legs of birds, and the fore and hind legs of animals are similar in many respects. Their use to man is, however, more important than any morphological comparisons. The relation of mammals, birds, and fish to man is emphasized in *Morang's Modern Nature Study*, pp. 28-31, pp. 68-71, and pp. 94, 95.

If fish are studied from the economic standpoint, *i.e.*, as food for man, the teacher must centre his study about their life history, and the protection of fish from those who destroy them for food. The species studied will depend upon the locality, but the white fish, perch, lake herring, and bass should be universally studied. The destruction of our fish has gone on rapidly in the last ten years. Much may be learned about fish from special reports, *e.g.*, the Ontario Game and Fish Commission's Report, 1892. Fish are very interesting in aquaria, but we are limited to small species or to the young of large species. Two or three fish of different species in an aquarium, will

demonstrate which species is most pugnacious. Put a young bass and a young shiner in an aquarium.

In addition to their use as food, fish destroy many larvæ of objectionable insects, such as mosquitoes. They also destroy many millions of flies that live about water, *e.g.*, May-flies. Possibly the great number of May-flies that annually emerge from our great lakes is due to the depletion of fish in our fresh waters. Make experiments by putting fish into aquaria with mosquito larvæ or other larvæ.

As the May-fly is a conspicuous insect in May and June, or later, it may be selected as a specimen for study. Look under stones in the shallow water of creeks or rivers. Larvæ of different species of insects will be found—May-flies, stone-flies and caddis-flies. The first are distinguished by the three narrow projections at the end of the abdomen; the second by two projections. The larvæ of caddis-flies are encased in peculiarly constructed cases, made of grains of sand, pebbles, small shells, or sticks. These larvæ are very suitable for school aquaria, being easy to keep and interesting to observe. Under a small microscope the larva of the May-fly is doubly interesting.

From the muddy bottoms of stagnant pools the larvæ of the dragon-fly may be obtained. These have already been mentioned under Form III. Living forms are always interesting, however, and these should be studied again in this grade. Structural peculiarities should be observed now, and the larvæ of different species of dragon-flies should be looked for.

Refer to what has been said under Form III on the study of the apple tree. Make a study of the several insect pests infesting the apple, pear, plum, and peach trees.

The various galls found on golden-rod, oak leaves and branches, maple leaves, rose bushes, witch hazel

leaves, willows (pine-cone willow gall), etc., are convenient and useful forms to study. Nothing need be told to the pupils, but suggestions on how to discover the cause of the galls may be made by the teacher. Ask the pupils to collect these various kinds of galls late in the fall. They will be interested in observing the various kinds of moths, flies, and wasps that emerge from the different species. The galls may be kept throughout the winter in a small box covered with a piece of glass.

That plants should make such peculiar abnormal growths for the purpose of protecting their enemies seems, at first glance, a perversion of the order of nature. Careful observation and reasoning will prove, however, that, primarily, these galls protect the plant, and, secondarily, form a home for the insect larvæ. If the golden-rod did not enlarge its stem at the point of attack, it would be so weakened there as to break off with the first strong wind.

Our commonest insects are least known. Few people know the life history of the house-fly or the mosquito, nor are they very much concerned about their existence. Dr. L. O. Howard, author of *The Insect Book*, says: "The house-fly undoubtedly distributes disease germs. Late investigations have shown that certain flies, and especially the common house-fly, is responsible for the spread of Asiatic cholera and typhoid fever." He also says that a pound of horse manure may contain 1,200 house-flies. As the eggs are laid in horse manure and the larvæ live there, and the pupæ are formed there, it is evident that the teacher must read or tell the life history of the fly to the pupils. Much may be learned by observation, however, as, for instance, the fact that female flies live through the winter in sheltered places, reviving in the spring, ready to lay eggs for a new brood.

Give your pupils this problem. If a fly during its lifetime lays 120 eggs, which hatch and complete their full life history in 10 days, how many flies may be produced by one fly in 100 days, if half of each brood are females? They will get tired before finishing the problem.

Advise children to screen windows, to chase flies out of the house, and to throw chloride of lime on piles of horse manure, or better, to remove the manure on to land weekly and spread it or plough it under.

Of the mosquito more may be said and observed. Its life history may be easily traced out by securing the larvæ (wrigglers), and transferring them to a bottle covered with cheese cloth. The pupæ, adults, and possibly eggs, may be observed in such a breeding-cage.

Tell your pupils that one species of mosquito, Anopheles, is responsible for the spread of malaria; while in the Southern States, another species of Culex spreads yellow fever. The destruction of the pest thus becomes a necessity, aside from the unpleasant results of its bite, which are quite serious with some people.

Experiment with the larvæ in your breeding aquarium.

1. Put fish into the water.
2. Pour kerosene on the surface.
3. Add potassium permanganate in small quantities.

If the larvæ always live in stagnant water, evidently the simplest way of preventing their breeding is to drain all stagnant pools near one's home. Mosquitoes do not fly far from their breeding places, but wind may carry them some distance.

Look for mosquitoes in protected places in winter months, under boards, in old wood piles, etc.

Distinguish the mosquito from the fly. Compare wings, legs, feelers, body.

The ants, bees and wasps should be studied in

this grade. See *Morang's Modern Nature Study*, pp. 175-87. An artificial nest for ants may be made as follows: Secure two panes of window glass, ten inches square, a sheet of tin eleven inches square, and a piece of plank one and one-fourth inches thick, twenty inches long, and sixteen inches wide. Cut a small triangular piece from one corner of one of the sheets of glass. From the sheet of tin make a tray three-eighths of an inch in depth. Cut a deep furrow on the upper side of the plank, near the edge, to serve as a moat, which, filled with water, will keep the ants from escaping. Paint the plank with several coats of paint.

Now place the tin tray on the plank, the square pane of glass on the tray. Lay strips of wood one-half inch wide and slightly thicker than the ant's body, on the glass. Fill in the space bounded by the wood with fine earth, lay on top the piece of glass from which the triangular piece has been cut and cover with a piece of blackened tin the same size and shape as the upper piece of glass. Hunt for an ant's nest. Secure the queen and several workers, eggs, pupæ, etc., if present. Transfer to the nest.

The relation between ants and plant lice should be discovered. Do ants destroy or protect plant lice (aphids)?

The study of the humble-bee may well be confined to its work in distributing pollen from flower to flower. It is interesting to examine a living bee to note where the pollen is gathered, on the back, face, antennæ, legs or abdomen. Bee bread, with which the young bees are fed, is a mixture of pollen and honey. See Bulletin No. 124, Ontario Agricultural College, for a description of how to observe bees. See also the article, *What the Little Bee is Doing*, p. 94, of the Report of the Ontario Fruit Growers' Association for 1904. Ask

some apiarist for an observation-hive to use in the school-room.

Any one who works about rose bushes will sometimes find strange cuttings on the leaves, some round, some oblong. The first thought is that these attacks are the work of insect larvæ. But you will find some pieces nearly cut out, then left. No one has seen any insect about, but the conclusion is that some insect is carrying away pieces of rose leaves for some purpose. Why? Two reasons will suggest themselves, *i.e.*, to build a nest or to store for food. Count the number of oval pieces removed and the number of circular pieces. In one case 27 to 11 was the ratio. Advise pupils to be on the lookout for these pieces of rose leaves. After several weeks have elapsed a boy rushes up to the teacher some morning with: "I have found some queer nests under some old shingles on our house. They look as if made of those rose leaves." The teacher says, "Bring as many as you can get." The boy brings some long four-sided structures with rounded corners. These break up into short sections. Dissect them. Behold the pieces of rose leaves, the oblong ones used for the walls, the circular ones for caps or plugs. Count again to discover the ratio; 29 to 12 was obtained in one case. Inside is a thin cocoon, and inside this a soft "grub." Pupils who have learned the life history of any common insect will conclude that this is a larva of some insect. In some cases a pupa will be found. Let the pupils keep these until adults emerge. The mystery will then be solved—a leaf-cutting bee is the offender.

The nests of wasps are equally interesting. Some boy brings in a mass of clay cells containing larvæ. Lead the pupils to discover everything possible about them; then keep the larvæ until adults emerge.

The paper nests of the social wasps may be collected in the fall without danger of the collector being attacked by the few dormant wasps that are still inhabiting them. Try to establish a relation between the fabric made by these original paper-makers and our common paper made from wood pulp.

At such times take up selections from literature in which these insects are mentioned.

Parasitic flies come under the head of nature's insecticides. Syrphus flies are found on flowers in August and September, or even in October. They resemble bees, and on that account are free from interference of insect hunters. Once distinguished from bees, they are easily recognized. The possession of but one pair of wings shows that they belong to the fly family (Diptera). Howard says, "They are flower flies, par excellence." Look for them on garden flowers. "Almost all types of bees and wasps are mimicked by them. There are syrphus flies like honey bees, bumble-bees, social wasps and solitary wasps of several kinds." In the larval state they feed upon plant lice and other small insects. A common species is *Eristalis tenax*, whose larvæ live in soft mud or manure. These larvæ have very long "tails." Their adaptation to their habitat makes an interesting study.

Tachina flies are likewise parasitic, but more directly so. In this case the parent lays its eggs on the body of the host, usually a leaf-eating caterpillar. The fly is much like a house-fly, with stripes along the back of its thorax. Possibly the fly itself will escape one's notice, but if teacher and pupils will collect, in the fall, the cocoons of the tussock moth from trees, they will find many with egg masses on them, many empty, and many dead. Open these dead ones. They may contain larvæ or pupæ. Let pupils draw conclusions,

warning them to bear in mind that no larva is capable of reproducing its kind. Place several of these dead larvæ or pupa-cases in a covered box, and eventually the adult insects will emerge. This is a much better way of discovering parasitic insects than by hunting for adults and classifying by means of a book. However, ichneumon flies are so striking with, in the case of the female of one species, the long, three-parted, tail-like ovipositors, that the adult is sure to be met with at work depositing its eggs in the tunnels of borers. As the larval life is passed in the bodies of borer larvæ under the bark of a tree, it is not easy to learn the life history at first hand.

The life history of the plum curculio should be worked out in this Form. Secure plums that have been stung. Keep under cover until the larvæ pass into pupæ, and eventually into the adult beetle stage. Its small size protects the plum curculio from ordinary observation. Look for its depredations on other fruits, *e.g.*, peach, cherry. Compare the effect on different fruits. Begin early in the season to look for stung fruit. If fruit is found to be affected, spread a sheet under the branches and jar the tree, but do not shake it. The adult beetles will drop, as so many insects do when apprehensive of danger. The beetle is less than a quarter of an inch in length. Look for the snout, which is bent back under the body when not in use. Spraying with Paris green also destroys this beetle.

"*Plant Life.—Study of organs of plants and their functions; study of economic and wild plants from seed to fruit in the school garden, home garden, farm, and forest; weeds injurious to crops and methods of destroying them; buds and twigs.*"

Enough has been said about school gardens. These should lead to the establishment of home gardens,

and the study of plants should be closely related to both. Transplant ferns, flowers, and vines, from the forest into suitable locations around the school or the home. Domestication of wild fruits and animals has practically ceased. There is no reason why it should not be revived. There are hundreds of species of wild flowers to experiment with. If some motive, such as producing a new or an improved species, is established, pupils will want to discover the functions of the parts, and will be interested in cross-fertilization. In this work, the insects must be prevented from visiting the flowers. It needs no special scientific knowledge to accomplish important results. Mr. Groff, of Simcoe, Ont., has made such a success of gladioli, forming new species at will, that he is known over the whole American continent. It is this kind of a result that we ought to aim at, not the collection and labelling of dried specimens, a method which destroys species instead of creating them.

Classification and collection are doubtless useful in some respects. But why waste precious time classifying and collecting plants commonly known? Limit the number to be collected each year to not more than twenty, and make the collection represent life history rather than the mature plant. The seedling is always different from the plant. The early summer plant may differ markedly from the fall condition, while the plant in bud, in full bloom, and in fruit, offers an interesting field for comparison. If such is the aim, the mere discovery of the name of the plant is of very little importance. The teacher may tell the pupil what it is, or direct him to some book in which he may find it.

The study of weeds injurious to crops, and methods of destroying them, is of special importance. This subject is treated fully in Bulletin No. 128, Ontario

Agricultural College. This bulletin should be in the hands of every teacher, in the rural schools at least.

The study of buds and twigs will be a part of the life history of the plant. Discover at what time buds are formed, and their relation to flowers and leaves. To the careful observer every twig has its history recorded upon its surface. There are leaf scars, scars of bud scales marking off the year's growth, terminal and lateral buds, and breathing pores (lenticels). See that the pupils are familiar with the normal twigs of the apple, pear and plum; the maple, horse-chestnut and spruce, so that they may be able to decide as to abnormalities.

"*Trees.—Wood, rings, grain, bark, uses.*"

By the time pupils have reached Form IV, they are supposed to be familiar with the forms of the common trees, and to have some knowledge of the purpose which trees serve in nature. In this Form attention is directed to the internal structure of the tree, and to its value in the commercial world.

In the study of wood, any section of a small tree, freshly cut, or, better still, the stump of a large tree recently cut down, will serve pupils to distinguish readily the four divisions in the wood: 1st, the dark centre, the dry, dead, part of the tree; 2nd, the sap-wood forming the body of the tree around the dark centre; 3rd, the cambium layer of cells in which the actual growth of the tree takes place, and 4th, the bark, or corky covering of the tree.

These divisions of the skin or trunk will be readily learned through the process of grafting. In grafting it is necessary to learn where the actual growth takes place, as the growing area of the two parts must be brought together. For directions for grafting, see Bulletins Nos. 124 and 144, Ontario Agricultural College.

Pupils should be able to draw conclusions as to what takes place each year in connection with the growth of the tree. Last year's cambium layer has this year become part of the sapwood, and a little more of the sapwood has dried out and become darker in color like the centre of the tree. Each successive cambium layer that becomes part of the solid tree forms a ring, and with some trees it is possible, by counting these rings, to tell how old the tree is.

Besides these rings pupils will notice that fine lines run from the centre of the tree to the bark. These lines are called medullary rays or pith rays, and they help to give the grained appearance to the wood. Pupils should make a collection of specimens of different kinds of wood found in the locality. These specimens should of course be uniform in size and should show the grain of each species of tree distinctly. Each specimen should be labelled and should be provided with a hook or eyelet, so that the collection may be displayed on a rack on the wall.

A study of the uses of various kinds of wood will lead pupils to examine the furnishings of the schoolroom, furniture at home, building materials, implements, etc., to see what kind of wood has been used in their manufacture. For example, the hard maple (sometimes having round points in the fibre which give it the name of birds'-eye maple), is used for furniture and wood-work of houses; the white ash is used for handles of tools, oars, interior of carriages, etc.; walnut is used for cabinet-making, gun-stocks, coffins, etc.; hickory is used for parts of implements requiring great strength and toughness; the white birch is used for shoe lasts, pegs, spools, etc.; chestnut, cedar, and other trees are used for ties, rails, etc., because they are durable when in contact with the soil. The white oak is used in shipbuilding, for furniture, interior

finish of houses, etc. The elm is used for making wheels, staves, floors, boats, etc. Needless to say, a knowledge of these facts is invaluable both to city and to country pupils.

Side by side with the study of the wood should go the study of the bark. Examination will show that a certain part of the bark, the part outside the cork "skin" of the tree, is dead. Sometimes this cork covering or skin is on the very outside of the tree, as in the case of the beech, and then the bark is smooth and there is little or no dead coating. Sometimes it is set in deep as in the case of the sugar maple, and then the trunk is ribbed and ridged; for as the tree grows from year to year this dead outside covering must naturally crack and split. Sometimes, as in the case of the buttonwood, the dead bark falls off every year, and the tree wears its new white garment of fresh bark throughout the winter. In some trees, as the shagbark hickory and the silver maple, the cork covering is itself irregular in shape, and the outer bark consequently peels off in scales or plates instead of breaking into furrows.

It should be noted that the bark of some trees has a commercial value. From the bark of the white birch canoes are made, and the bark of the hemlock is used in tanning leather. A Muskoka farm, even if it be too rocky for profitable agriculture, is a valuable asset if covered with a good growth of hemlock.

Winter is perhaps the best time of the year to study the bark of trees, and the relation of the bark to the rest of the tree should then be specially noted. The cork covering of the tree forms a watertight jacket to keep the moisture of the tree from evaporating, and the tree from drying out. Careful examination will show that even the lenticels or breathing holes in the bark of the tree are sealed up. Each bud and twig is covered with a coating of hair or gum, and even the tiny rootlets are

wrapped up in cork jackets for the winter. The effect of this cork covering in protecting the tree may readily be seen by comparison with a potato. The peeling of the potato is a corky texture, and when it is removed the potato dries up very quickly.

Pupils should propagate geraniums, begonias, foliage plants, strawberries, raspberries, roses, etc., in order to supply window boxes or garden plots. Again we say, if these are not to be raised, do not waste time talking about means of propagation. It is no whit better to be memorizing rules for propagating plants than to be memorizing lists of names—in fact, it is much worse, for it violates all nature.

"*Observing local minerals and rocks, their properties and uses.*"

The work in geography requires that pupils know the products of their own and other countries. Minerals are very important products and rocks are extensively used in building. It is only reasonable, therefore, that pupils should know the nature of mineral ores. If the school is not in the vicinity of rock quarries or mines, secure specimens of common rocks, granite, quartz, sandstone, limestone, etc., and of mineral ores of common minerals, *e.g.*, copper, lead, iron, tin, asbestos, zinc, nickel and silver. Pupils should familiarize themselves with the general appearance, color and hardness of these ores.

A table of hardness may be roughly made out as follows:

1. Scratched by finger nail ∴ softer than finger nail.
2. Does not yield to the finger nail. Does not scratch copper.
3. About as hard as copper.
4. Between 3 and 5.

5. Scratches glass feebly. Yields easily to knife.
6. Scratches glass easily.
7. Yields with difficulty to edge of file.
8. Harder than flint or rock crystal.

The minerals which form a series of successively hard substances from 1 to 10 are:

1. Foliated Tale or Graphite.
2. Rock Salt or Mica.
3. Calcite.
4. Fluor Spar.
5. Apatite.
6. Feldspar.
7. Rock Crystal, Quartz.
8. Topaz.
9. Corundum.
10. Diamond.

Many substances that look alike, *e.g.*, copper pyrites and iron pyrites, are immediately distinguished by their hardness. The latter will scratch glass, the former will not. Many white specimens are distinguished in the same way. Calcite looks much like quartz, though possibly smoother, but it will not scratch glass, while quartz readily does so.

It is quite out of the question in public school work to study mineralogy, but some familiarity with common ores can be acquired without much effort, and much may be gained thereby. Ask the Geological Department at Ottawa for specimens of common Canadian rocks and ores. These will be delivered, already labelled and named. See *Morang's Modern Nature Study*, pp. 282-4.

"*Experiments to show composition of soils and their relation to drainage, temperature, etc.; varieties of soils adapted to different crops; fertilizers.*"

See what has been said under Form III on soils. In this Form, show pupils the litmus paper tests for acids and antacids (alkalies), *i.e.*, acids turn blue litmus paper red, and alkalies turn red litmus blue.

Test soils with litmus paper to determine whether acid or alkaline in reaction.

Show pupils, by adding acid to an alkali, *e.g.*, vinegar to ammonia, that an acid destroys an alkali; and by adding ammonia to vinegar, that an alkali destroys an acid. Use litmus paper to indicate the change. If soils are very acid or very alkaline in reaction, they should be treated so as to destroy the acidity or alkalinity, respectively. Pupils should be able to tell how to do this after seeing the above experiments. The question is, what kind of substance shall be used? Let pupils test lime for acidity or alkalinity. Upon what soils should it be placed? Tell pupils that experience has proven that, for sour or acid soils, lime is the best substance to destroy the acidity. If soils are very alkaline, acids in some form must be added. Clover ploughed under will help such soils; or superphosphate of lime may be used to advantage.

Consider the effects of drainage and tillage on sour, wet soils. Take two tin cans, punch the bottom of one full of small holes. Place over these holes broken pieces of flower pots and gravel to the depth of an inch, then fill up with wet, *sour* soil, as indicated by litmus paper. Fill the other can with the same kind of soil, without providing for drainage. Keep working over the soil in the can that is drained. Test from time to time for acidity. Tell the pupils that air contains some ammonia. Ask them to explain the effect on sour soil, of letting air containing ammonia circulate freely through it.

Mr. C. C. James, Deputy Minister of Agriculture for Ontario, says: "Thorough drainage and tillage—these are the two main points in improving all soils. They are even more important than manuring. This word manure is the same as manœuvre,

which means 'to work by hand'; the draining of the soil and the tilling are means of fertilizing or manuring. The deeper the soil is worked, the freer the access of the air and the better the soil."

Germinate seeds in sour soils and in well-aired, sweet soils. Compare results. Try liming the sour soils. Compare with growth on unlimed soils. Give the lime time to mix with the soil before planting anything in it.

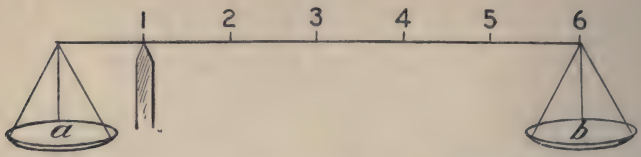
Ammonia not only neutralizes the acids in sour soils, but it serves as a valuable food for plants. House plants often grow better if watered with water to which a little ammonia has been added—a dessertspoonful to a quart is sufficient. Experiment with half a dozen plants of the same kind. Water one with ordinary well water or tap water, another with rain water, a third with ammonia water of strength mentioned above, a fourth with stronger ammonia solution, a fifth still stronger, etc. Try to discover the best strength of ammonia solution. Use other solutions and experiment in the same way. Saltpetre may also be tried.

Ammonia, saltpetre, and most manures, are valuable because they contain nitrogen. Four-fifths of the atmosphere is nitrogen, but plants cannot assimilate this free nitrogen. A valuable discovery has been made, however, in connection with plants like clover, pease, beans, etc. On the roots of these plants are little swellings, in which certain kinds of bacteria live. These bacteria are able to assimilate nitrogen directly from the air, and the plants then make use of it. Hence clover, pease and beans tend to increase the amount of nitrogen in the soil, and should precede crops like wheat, which require a good deal of nitrogen in order to mature well. See Bulletin No. 148, Ontario Agricultural College.

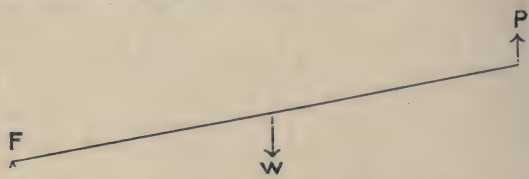
"*Implements and tools used on the farm and in the household; mechanical principles applied in their construction.*"

The writer began the study of "Natural Philosophy" at an early age, and continued it for many years, until at last it became modified to the present physical science course. In those early days the whole work consisted in working problems, based upon the study of lever, pulleys, inclined plane, wheel and axle, screw and wedge, but there was no experimental work of even the simplest kind. After many years of this kind of study, a real problem presented itself, in which it was necessary to use pulleys to raise a very heavy door leading to a cellar. It was then discovered that the knowledge gained was lamentably inadequate. The real problem was solved, however, and ever afterwards problems regarding the relation of power to weight in a system of pulleys were much more interesting and much more readily solved. Had the *real* knowledge come first, as it should, much valuable time would have been saved, and the culture value of the book problems would have been vastly increased. Let modern teachers see that modern methods prevail. Go as far as experiment can take you and your pupils, but no further. Expend your time and effort on real problems as they arise in experience.

The simplest tool is the lever. Secure a strong, straight stick, about six feet long, as light as possible in order to sustain the weight required. Mark off the length into six equal parts. Rest the stick at its first division across the narrow edge of a board, as indicated in the diagram.



Attach scale pans to each end and balance the whole by placing weights in pan A. Now place a 5-pound weight, or any convenient weight not exceeding the capacity of an ordinary dynamometer* (12 pounds). Apply the dynamometer at point 2 and record the pull necessary to balance the 5 pounds. Apply at 3, 4, 5 and 6 respectively, recording the pull in each case. Discover the relation of the pull required at each point to the distance of the dynamometer from the point 1. Draw conclusions as to the principle of the lever in the relation of power and weight in this arrangement when the point of support, the fulcrum, is between the power and the weight. Then investigate the relations of power and weight when both are on the same side of the fulcrum, thus,



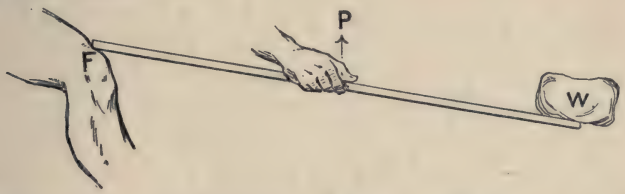
and finally, when the power is between the weight and the fulcrum, thus,

*Dynamometers may be secured from a dealer in school supplies at 25 or 50 cents each. Hardware merchants are not allowed to sell them.

Introduce each case of the lever with the actual moving of some weight. The first case is that of the common pry or handspike, prying downwards upon a block, thus,

If the pry is used by shoving against the weight, the ground forming the fulcrum, we have the weight between the power and the fulcrum.

If the pry is used by resting one end on the knee, grasping the pry with the hand and lifting a weight at the end of it, we have the power between the weight and the fulcrum.



Discover by experiment which condition is most economical of power, *i.e.*, the one in which the relation of power to weight is least.

Pulleys are so common in connection with hay-forks, that every country child has the object before him long before the principle involved is considered. Arrange a miniature system to illustrate the fork.

Determine experimentally the relation between power and weight. Owing to friction it is difficult

to establish exact principles by these experiments, but the inexact results obtained by experiment are far more valuable than the exact abstract impossibilities arrived at from pure mathematics. The wheel and axle is often used in drawing water from a well or in raising weights; the inclined plane is a common device in the form of a sloping plank. Make experiments with each, even if the results are expressed merely as greater and smaller, without indicating exact proportions.

"*The atmosphere*; *its composition*."

Many simple experiments are possible to show common properties of the air. We may burn out some of the air under a glass, inverted over water, and observe the consequent rise of water to take the place of the part burned away. This is most simply done by placing a few heads of matches on a floating cork and inverting a glass jar over them, just after they are made to burn. The result will, however, be only approximately correct at best. Tell the pupils that oxygen is burned out and that it forms about one-fifth of the air by volume. Show that the portion of air remaining will not support the combustion of a candle, match, etc. The small traces of ammonia, carbon dioxide, and argon, in the air cannot be demonstrated by experiment.

When the amount of carbon dioxide exceeds four parts in 10,000, its presence may be detected by the following method: Bring a 10-ounce bottle filled with water into the room the air of which is to be tested. Empty the water, thereby filling the bottle with the air of the room. Add a half ounce of lime water. Shake vigorously. If the lime water becomes clouded, the quantity of carbon dioxide is too great for health.

The fact that carbon dioxide is given off from the lungs is proved by passing expired air through lime water. Taking the result as a test of carbon dioxide, investigate the product of combustion of a burning candle, splinter, or lamp flame, by holding a wide-mouthed bottle over each for a few seconds, and then testing with lime water as above. Deduce from these tests the vitiation of the atmosphere by people, animals, gas flames, etc. Ignorance with regard to this vitiation of the atmosphere in the case of large coal-oil stoves or gas radiators is inexcusable. Emphasize the fact that a constant supply of fresh air is needed.

That water is a product of any ordinary flame can be demonstrated by holding a tin cup, filled with snow or ice, in the flame for a few seconds. If the cup is kept cool by putting ice or snow in it, enough water may be collected to be appreciable. Devise some method of condensing the steam from boiling water so as to obtain distilled water.

"*Reciprocal relation of plants and animals as regards the atmosphere.*"

This is best demonstrated by beginning with life in an aquarium. Fish live in an aquarium in which plants are growing. Place the same fish in water in which there are no plants and they die. It is possible to collect gas from water plants if the aquarium is placed in direct sunlight. If enough can be collected show that the gas is oxygen. From what is known of the production of carbon dioxide by animals, lead to the conclusion that the plants must use up this carbon dioxide, and thereby continue their growth, giving off oxygen for the respiration of the animals. Animals and plants in the air have exactly the same relation as in the water. This may be explained after

a careful study of balance in the aquarium. Questions of ventilation should be discussed in this connection.

"*Impurities in the air.*"

We have dealt with carbon dioxide. Its presence is evidence of the probable existence of organic impurities, the waste tissue of the different parts of the body, especially the lungs.

The *Nature Study Review*, January, 1906, gives a simple way of proving the presence of putrefactive germs in the air and in dust: "Prepare seven tubes for containing clear beef broth. Ordinary test-tubes, 5 inches long, are the best, but ordinary bottles, though not quite so convenient, answer every purpose. Clean the tubes or bottles thoroughly, dry them and plug each tube with cotton. Then place them in the oven of your kitchen stove, and bake them just long enough to turn the cotton slightly yellow. . . . This we call sterilizing the tube. . . . Now prepare your broth to put into these tubes. You may make the broth by allowing some chopped meat covered with water to soak over night, and then squeezing it through a piece of cheese cloth to get the liquid out. Boil this liquid and pass it through filter paper in order to make it clear. Any druggist will let you have a piece of filter paper and will show you how to use it. When you have got the broth clear, place a little of it, say two inches deep, in each of your test-tubes. In opening the tubes and pouring the broth in, it is possible that some germs from the air may fall into your broth. You must therefore again sterilize the tubes and the broth in them. . . You must steam them in a steamer for thirty minutes. One steaming is not sufficient. . . . You must steam them thirty minutes to-day, thirty minutes

to-morrow, and thirty minutes next day.* After the third day the broth is completely sterilized.

"Now for the experiment. You may set tube No. 1 away without opening it at all. From No. 2 you may take out the stopper, keep it out one minute, then replace it. From No. 3 you may remove the stopper and leave it out thirty minutes. From No. 4 remove the stopper, then pick up a little dust on the point of a knife and drop it into the tube. . . . To No. 5 add dust as in No. 4, close the tube and set it in a pan of boiling water for 10 minutes. To No. 6 add dust as you did in No. 4. and also add a little carbolic acid. To No. 7 add a drop of ordinary drinking water. Now set the tubes away in a moderately warm place, and look at them day by day for a week or two. Any cloudiness or change that occurs means decay. Draw conclusions from the different results. Such an experiment is of great value to girls who may be interested in preserving fruit, milk, etc."

"*Gravity, air and liquid pressure, the barometer. Cohesion and adhesion, the nature of these forces; phenomenon of solution and diffusion; amorphous and crystalline forms of matter. Practical use of heat, steam and electricity in connection with the study of industries.*"

Pupils know that magnets attract iron and that all heavy bodies fall to the earth if unsupported. They must recognize that the magnet attracts the iron, and it is easy to explain the falling of bodies by reasoning that the earth attracts them. This attraction, which exists between all bodies in proportion to their masses, is called gravity when the earth is the attracting body. It is this that makes all bodies weigh something. When the body is placed on the

*The steaming may be done after cooling for two hours or so.

scale pan, the earth continues to pull upon them and the scale pan is lowered. Weights placed on the opposite scale pan will balance the given body as soon as the pull of the earth upon them is equal to the pull upon the given body. The effect of this force of gravity upon falling bodies cannot, however, be definitely demonstrated in this grade.

For the remainder of the foregoing work see any book on elementary physical science.

Be sure that pupils have a motive for studying each topic. If no motive exists beyond the mere learning about cohesion, etc., wait until a motive arises, or create one.

APPENDIX A

The Ontario Course in Nature Study and Elementary Science

GENERAL

From the character of the subject the course must be more or less elastic, and the topics detailed in the programme are intended to be suggestive rather than prescriptive. It may be that, owing to local conditions, topics not named are amongst the best that can be used, but all substitutions and changes shall be made a subject of consultation with the Inspector. The treatment of the subject must always be suited to the age and experience of the pupils, and to the seasons of the year, accessibility of materials, etc. Notes shall not be dictated by the teacher. Mere information, whether from book, written note, or even the teacher, is not Nature Study. The acquisition of knowledge must be made secondary to awakening and maintaining the pupil's interest in nature and to training him to habits of observation and investigation. Books for reference and supplementary reading should, however, be provided in the school library. Some valuable publications on the subject of Nature Study, for the teacher's use, may be obtained free on application to the Department of Agriculture, Toronto.

FORM I

Animal Life.—

General appearance and habits of pet animals, their care and food; domestic animals on the farm, their care, habits and uses; birds, their nesting, song, food, migrations in the autumn; metamorphosis of a few conspicuous butterflies or moths.

PLANT LIFE.—

Work in school garden or in window boxes; study of a plant, as a geranium or pansy, from slip or seed to flower; caring for plants in pots; buds, their preparation for winter, their development; autumn leaves, collections, forms, tints; economic fruits, collection, forms, how stored for winter, fruit as seed holders, dissemination of seeds; roots and stems, uses, comparison of fleshy forms, how stored for winter.

LIFE ON THE FARM.—

Harvesting, primitive and modern methods compared; preparation for winter; the barn and its uses; activities of the farm during winter; winter sports and social life on the farm; the varied operations of spring time; spring time as awakening to new life; effects of sun and moisture on the soil.

FORM II

Course of Form I continued

ANIMAL LIFE.—

Life-history and habits of domestic animals and of familiar wild animals, as the squirrel, chipmunk, robin, crow; earthworm, habits, structure, uses; toad, habits, structure, uses; observation of live insects and their activities, comparison of young and adult stages.

PLANT LIFE.—

Co-operative and individual work in school garden; cultivation of plants in pots with observation of the development of leaves and flowers; parts of leaves and flowers; change of flower to fruit and of fruit to seed; functions of the parts of flowers; the forms and uses of trees; activities connected with forestry and lumbering, with study of pioneer life and present conditions on the prairie.

Observation of farm, garden, and household operations.

FORM III

Course of Form II continued

ANIMAL LIFE.—

Adaptation of different kinds of animals to their respective habits and surroundings; birds, life-history of types, habits of wild fowl in different seasons; fish, forms and uses of different parts of the body, food and how obtained; life-histories of moths, butterflies, beetles and grasshoppers; useful insects, as ladybird and dragon fly; harmful insects; nature's insecticides.

PLANT LIFE.—

Germination of seeds under controllable conditions and in the school garden and window boxes; opening of buds; study of the forms and functions of the parts of plants, and comparison of these forms and functions in different plants; observation of the culture of farm and garden crops and of orchard and shade trees; the observing and the distinguishing of the common forest trees.

Different kinds of soil, as sand, gravel, loam, leaf-mould and clay; experiments to ascertain how soils are composed, whether of mineral or of decayed organic material, and which best retains water. Additional phenomena of spring in the vicinity of the school, cause of snow melting, ice floating, etc.; how nature prepares the soil for growth of plants. Distinction between hard and soft, pure and impure water; tests and methods of purification of water.

SOURCES OF HEAT.—

Experiments to show the effects of heat in the expansion of solids, liquids, and gases; practical applications. Temperature; thermometer, construction and graduation. Methods of transmission of heat, conduction, convection, and radiation; causes of winds and ocean currents; ventilation.

FORM IV

Course of Form III continued

ANIMAL LIFE.—

Relation of fish, birds, and wild animals to man; life-histories of conspicuous and economic insects; organs and functions.

PLANT LIFE.—

Study of organs of plants and their functions; study of economic and wild plants from seed to fruit in the school garden, home garden, farm, and forest; weeds injurious to crops and methods of destroying them; buds and twigs; wood, rings, grain, and bark, uses, etc.

OBSERVING LOCAL MINERALS AND ROCKS, THEIR PROPERTIES AND USES.—

Experiments to show composition of soils and their relation to drainage, temperature, etc.; varieties of soils adapted to different crops; fertilizers, etc. Implements and tools used on the farm and in the household, mechanical principles applied in their construction.

THE ATMOSPHERE.—

Its composition; combustion, simple experiments, study of candle flame products; changes produced in the air by respiration; reciprocal relation of plants and animals as regards the atmosphere; impurities in air.

GRAVITY.—

Air, and liquid pressure, the barometer. Cohesion and adhesion, the nature of these forces; phenomenon of solution and diffusion; amorphous and crystalline forms of matter. Practical use of heat, steam, and electricity in connection with the study of industries.

FORM V

Elementary Science

The first courses in Botany, Zoology, and Physics are prescribed for the Fifth Form of the Public Schools. Both the first and the second courses in Botany, Zoology, and Physics, and the course in Chemistry are prescribed for the Continuation Classes of the Public Schools and for the Lower School of the High Schools.

Botany

First Course—September to November

The structure and functions of flower, leaf, stem, root, etc.; organs of the flower, their functions, pollination, fertilization. Uses of hairs, spines, prickles, tendrils, and petioles. The simpler fruits and the means of dispersion of seeds. Formation of tree buds; preparation for winter; annuals, biennials, perennials. The fall of fruits and leaves of deciduous and evergreen trees. The study and interpretation of the marks on trees and shrubs. Comparison of higher plants with higher animals; relation of each to food; means of obtaining and storing it; dependence of animals on plants.

April to June

Relation of plants to light, moisture and heat; water as a solvent, circulation in plants, experiments; soluble and insoluble material in soils; importance of each class of material to the plant; uses of roots and leaves in absorbing food from soil and air, experiments. Struggle for light and moisture, germination of the seed, development of the parts; examples—bean, morning-glory, pumpkin, corn, wheat. The expanding of buds and the opening of the spring flowers. Objects of pruning trees, transplanting and thinning vegetables. Times of germination and flowering of common plants in their native situations. Propagation of offsets, runners, tubers, slips, seeds, grafts, budding.

Conditions governing the growth of the early wild flowers. Modifications in plant growth suitable to environment. Plant societies in different localities. Identification of plants with regular flowers.

Second Course—September to November

Morphology of the composites and grasses. Identification of the simpler ones.

Plant societies continued; peculiarities of each which adapt it to its situation. Special study of weeds, means of controlling them. Morphology and habits of some typical ferns, as bracken fern, shield fern, moon-wort, sensitive fern. Morphology and habits of a mushroom, a polypore, a boletus, a puff-ball. Parasitism and saprophytism. Study of plant enemies and remedial treatment—the simpler forms. Comparison of spring and autumn flowers. Comparative study of fruits. Special study of leaf, its modifications and adjustments for securing a favorable light position; its importance in obtaining and elaborating food material; the part it plays in evaporation.

April to June

Common orchard and forest trees. Special study of the coniferæ; the bud; form, permanence and phyllotaxy of leaves, flowers; comparison of twigs and wood with those of other trees. Comparative study of pith and cortical layers. Distinction between endogen and exogen. Meaning, significance, and methods of cross fertilization. Man's influence on plants. Plant physiology, elementary and experimental; chlorophyll; movements of gaseous and liquid nutriments and waste products. Morphology of complex inflorescences. Study of the fungi continued. Economic uses of plants, food, clothing, ornament, medicine, rubber, tea, spices, etc. General view and comparison of the characteristics of the larger classes of plants taken up in the course.

Zoology

First Course—September to November

Relations of insects to flowers. Study of grasshopper, potato-beetle, tomato-worm, house-fly, spider, centipede. The life-history of at least two insects having complete metamorphoses. Collection of caterpillars infesting common plants, for observation of their metamorphoses. Recognition of some of our common birds; the relation to their habits of the structure of bills, legs, feet, wings, and nests, the arrangement of toes, and the color of feathers and eggs (aquatic, terrestrial, aërial); times of their migrations.

April to June

The life-history of the frog. Continuation of the study of the birds; especially in regard to their methods of obtaining food and nesting. Life-history and habits of any common economic insects, such as the tent-caterpillar, the cabbage-butterfly, the ladybird, or other predacious beetle. Familiarity with the names and general appearance of the common fishes, frogs, newts, lizards, turtles, and snakes of the locality.

Second Course—September to November

The mammalia, chief characteristics. Our native Canadian mammals, their adaptation to our climate, their coloration, docility, habits, food, enemies. Modifications for aërial life (bat, flying-squirrel), arboreal life (squirrel), subterranean (woodchuck, mole), aquatic (beaver, muskrat). Herbivorous and carnivorous animals, peculiarities of each. Adaptation of the fish, the frog, the bird, the mammal, to their habits of life. Homologies of fins, scales, etc. Comparison of the teeth and integuments of a few typical animals. Adaptation of animals for securing food, avoiding enemies. Preparation of animals for winter.

April to June

The food supply of birds and insects; those beneficial or injurious. Special study of the bills and feet of birds and of the

mouths and wings of insects. Distinction between biting and sucking insects. Life-history of any two of the following: carpet-beetle, scale insect, saw-fly, codling moth, mosquito, pea-weevil; rearing the insects to study their metamorphosis; observation of conspicuous orchard or garden pests of the season, with protective treatment of plants. Economic uses of animal products: silk, wood, fur, leather, etc. General view and comparison of the larger classes of animals taken up in the course.

Physics

First Course—November to April

Forms of matter: solids, liquids, gases; different states of the same kind of matter; crystalline and amorphous conditions; theory of constitution of matter. Physical and chemical change. Simple and compound substances. Metric units and standards of length, area, volume, weight, mass density; experiments in measurements with use of instruments, such as rule, balance, burette, caliper. Properties of solids. Properties of liquids; transmission of pressure by liquids; illustrations, construction and uses of hydraulic press. Relation of pressure to depth and density; pressure at a point equal in all directions; buoyancy and flotation. Properties of gases, weight, elasticity, atmospheric pressure, barometer; expansive force of gas, with applications, as air cushion, bicycle tire, football, compressed air motor, air gun, etc.; relation between the volume and the pressure of gas (Boyle's law). Construction and use of air pump, common pump, force pump, condenser, (as bicycle pump); buoyant force of gases. Solution, diffusion; part played by these processes in nature. Specific gravity; common methods of finding specific gravities of solids, liquids, and gases.

Second Course—November to April

Experiments illustrating the transformation of other forms of energy into heat; experiments to illustrate the expansion of solids, liquids, and gases by heat; distinction between temperature

and heat. Methods of measuring the change of temperature, with description of centigrade and Fahrenheit thermometers; change of state, phenomena of fusion, ebullition, evaporation, liquefaction and solidification; latent heat; methods of transference of heat; conduction, practical methods of heat insulation, principle of Davy's safety lamp, convection currents; methods of heating and ventilating houses.

Lode-stone, magnetic attraction; magnetization and demagnetization; polarity; magnetic induction: earth's inductive influence; construction and practical use of the mariner's compass and dipping needle; geographical and magnetic poles; construction of simple voltaic cells; chemical effects of the electric current, decomposition of water by electricity; magnetizing effects of the electric current; the construction of an electro-magnet, with some of its more common practical applications, as electric bell, telegraph, and telephone; heating and lighting effects of the current, arc and incandescent lamps.

Nature and propagation of sound; principles of construction of some of the more common musical instruments, as piano, violin, harp, horn, and organ; reflection of sound, echoes; musical tones; pitch and quality.

Nature and propagation of light, simple experiments illustrating the reflection and retraction of light; the prism, the dispersion of light, color.

Chemistry

Oxygen: preparation, properties; oxidation, examples; combustion; reduction; dependence of organic world on oxygen. Water: decomposition by electricity, common impurities, tests. Hydrogen: preparation and properties. Ammonia: preparation, properties, economic uses. Carbon: forms, occurrence, properties and uses; carbon dioxide, preparation by combustion in air, occurrence in the atmosphere, preparation from limestone, properties, comparison with air, relation to plant and animal life, tests; carbonic acid. Limestone: forms, occurrence; lime and its manufacture; action of water on quick lime; action of

acids on limestone; other carbonates; mortar, building stone, animal shells, uses of limestone and its products. Air: separation of oxygen from nitrogen; properties of the latter. Acids, bases, salts, distinguishing characteristics.

NOTE 1.—The objects of the course are to train pupils in correct observation and deduction; to give, in connection with the instruction in Geography, a fair knowledge of the world around them to those who will remain at school only a year or so; and to lay the foundation for the more detailed study of each subject in the case of those who will continue the work. The spirit of the Nature Study of the lower forms should be retained, but the teacher should introduce a more systematic treatment of the subject with such organization of the material in Botany and Zoology as will lead to simple classification. The course should be correlated with Geography, Drawing and Composition.

NOTE 2.—The order of the topics here given is merely a suggested one. In Botany and Zoology, the extent and the character of the details of each topic are left to the principal and the teacher, and should be determined by the accessibility of the material and other local considerations. The course in these subjects should be practical throughout. Each pupil should possess a good lens and be taught how to use it. Approved methods of collecting and preserving botanical specimens and of keeping live animals suitable for study should be systematically followed. An herbarium and a museum of local specimens should be provided where practicable. The pupils should be encouraged to provide specimens from the locality. Much of the practical work, especially the observations, will necessarily be done out of doors by the pupils alone, under the direction of the teacher, or by the pupils conducted by the teacher. The course in Physics should be experimental as far as possible, and the pupils should be encouraged to work at home and to prepare simple apparatus. The amount of the apparatus required is at the discretion of the Public School Inspector.

NOTE 3.—Books for reference and for supplementary reading should be provided in the school library. Systematic written descriptions and drawing should be required throughout the course, and the exercises should be dated and presented for comparison and inspection, the work being systematically supervised by the teacher. In none of the science subjects shall notes be dictated by the teacher.

APPENDIX B

The Manitoba Course in Nature Study and Elementary Science

GENERAL NOTE

This work has been arranged by grades, with definite topics for each. It does not follow, however, that all the material suggested shall be covered during the year. The course has been made wide enough to enable every teacher to select such topics as are suitable to the varying conditions met with.

In general, the treatment of a topic should involve the following:—

1. Observation by the pupils.
2. Expression—
   (*a*) By oral or written language, or both.
   (*b*) By drawing, painting or modelling.
   (*c*) Reading of descriptions, and study of selected literature, such as stories, myths, and poems.

Special Notes for Grades I and II.—

The purposes of the Nature work in Grades I and II should be the following:—

1. To develop the right moral spirit leading to sympathy, kind treatment and right feeling towards life, particularly towards animal life.

2. To develop the spiritual nature leading to reverence, truth, belief.

3. To cultivate a love for the beautiful, and to train in the expression of it.

4. To help the children to see those things in nature that are best worth seeing and to understand the meaning of the things seen.

5. To maintain an interest in school life and to aid in the work of other studies, especially language and literature.

GRADE I

PLANT LIFE.—

1. The anemone, pussy-willow, dandelion, golden-rod, gentian, or other typical plants, with reference to color, odor, beauty, season, home and the enjoyment afforded.

2. The making of bouquets for the school-room and the home. A study of color, harmony, arrangement and placing.

3. A study of a few common trees of the locality, such as the ash-leaved maple, elm, ash, the hawthorn, the willow and the poplar. Ready recognition of these by their general appearance, bark, leaves, etc. Their value as to beauty, shade, protection and wood.

4. The planting by each pupil of a few sun-flower and bean-seeds for the purpose of becoming acquainted with the beginning of plant life. Reference may be made to soil, moisture, temperature and season. Observation of root-hairs, root-branches, struggle of plantlets to get to the light, etc.

5. The planting, by each pupil, at school or at home, of nasturtiums, sweet-pease or other easy and suitable seeds for the purpose of developing the feeling of *ownership* and *personal interest.*

6. The coloring and falling of the leaves in autumn. The protection of the buds in winter. The swelling and opening of the buds in spring.

7. The trees in winter—general appearance, the long winter sleep, the deserted birds' nests, etc.

8. The scattering of the seeds. Reference being made to such plants as the dandelion, thistle, anemone, sweet-pea, wild cucumber, and to such trees as the basswood, poplar, maple, etc.

9. Collection and arrangement of material by individual pupils.

ANIMAL LIFE.—

1. Bird life. Reference to movements, habits, food, sun, beauty, enemies, nesting, care of the young birds, migration. A general appreciation of the companionship of the birds. Individual experiences of the pupils with particular birds.

2. Stories of birds.

3. The poultry-yard. Feeding and caring for the hens; gathering the eggs, observing the mother-hen and her family.

4. Birds in winter.

5. Butterflies and moths. Reference to color, beauty, movements, etc.

6. Study of simple life-history of butterfly or moth.

7. Conversations about domestic pets of pupils.

8. Conversations about some of the wild animals of the district.

9. Stories of animals.

10. Preparation for winter—by pupils, by animals, by insects.

INANIMATE LIFE.—

1. Introduction and development of terms describing direction and distance.

2. Observation of the weather. The winds, their direction and what they bring. Rain and snow, where they come from, their use.

3. The sun and the moon.

GRADE II

See General Note

PLANT LIFE.—

1. The planting by each pupil of pease and pumpkin seeds, as in Grade I.

2. The care of a geranium-slip in a pot. Each pupil to be responsible for the planting and care of his or her own.

3. The study of individual trees continued. The oak and the elm. Comparison of each with the trees already studied as to appearance, time of leafage, flowering, etc.

4. Acquaintance with a few of the more common plants of the roadside and the vacant lot. (From 8 to 13 plants should be studied.)

5. Collecting, arranging, mounting, sketching, and comparing of typical leaves.

Animal Life.—

1. Observation of a few of the common birds of the locality, particularly the pigeon, wild duck, wild goose, and the prairie chicken.

2. Incidental observation of the birds of the district, as in Grade I.

3. Observing the habits of the ant, bee, wasp, and grasshopper.

4. The study of the dog. Fidelity, courage, unselfish devotion, strength, endurance, intelligence, ability and willingness to learn. The dog as a companion and a playfellow. Games and tricks of the dog. Stories of dogs. Treatment. The wolf and the coyote.

Inanimate Nature.—

1. Dew. Where found? Where not found? When found?

2. Frost. The crystals. The frost pictures on the school window. The windows of a deserted house. Frost and dew. Frost and snow.

3. Clouds. Movements, appearance, beauty, usefulness, etc.

4. Snow. Where snow comes from. Appearance of the flakes. How snow beautifies the earth. The enjoyment snow brings.

Snow in relation to the bird, animal and plant life. The children of the Northland.

5. Learning to read the thermometer.

GRADE III

NOTE.—

Observation work of this grade should receive the following modification:—The field should be widened and some supplementary reading introduced; home geography should be given a more definite place on the school programme. Topics not directly within the range of the pupil's observation may be studied whenever the relationship is close to actual experience.

Drawing, as a means of expression, should be emphasized at every point. The literature bearing on each topic should be read by pupils and teachers.

PLANT LIFE.—

1. The germination of corn and scarlet-runner seeds, as in previous grades. Observations should be followed by oral description and drawing.

2. Observation of the marsh marigold, colt's foot, arrow leaf, cat-tail, or other water-loving plants.

3. Observation of such flowering shrubs as the hawthorn, cherry, plum, spirea, honeysuckle and lilac. A ready recognition of these.

4. The autumn flowers—gentian, pansy, petunia, aster, and golden-rod. Reference to season, appearance, etc.

5. Collection by pupils of leaves and dry fruits.

ANIMAL LIFE.—

1. The study of such birds as live near the water or frequent the meadows. Special reference to the red-winged blackbird, bobolink, and meadow-lark.

2. Incidental observation of the birds of the district.

3. The life-history of the toad or the frog.

4. The horse. Treated similarly to the "dog" of Grade II.

5. Familiar conversations about the wild animals of the district.

INANIMATE NATURE.—

1. Evaporation. Reference made to the tea-kettle, wash-day, sprinkling the floors and streets, the drying of roads, ponds, and clothes. A good drying day. Practical experiments at home and at school.

2. A hail-storm. Character of the weather preceding the storm. Appearance of clouds, wind. Observation of the hail-stones; damage done. The character of the resulting weather.

3 Making weather records during the months of January, April, June, and October.

4. A study of the common forms of land and water as an introduction to a subsequent world study. Such forms should include· hill, valley, slope, brook or creek, pond or slough, lake, meadow, upland, plain, cape, bay, isthmus, peninsula, etc.

GRADE IV

See note under Grade III

PLANT LIFE.—

1. Germination. Structure of the dry seed. Need of water. Parts of the embryo. Function of the seed-leaves, behavior of seed-leaves, as shown in the cases of seeds studied in previous grades.

2. The planting of a potato or a potato section by each pupil. Observation of growth from week to week. Keeping a record of this.

3. Study of cross-sections of twigs, branches and stems. The meaning of the rings and the story they tell.

4. Comparative study of (*a*) marsh marigold, anemone and buttercup, or (*b*) the potentilla, geum and strawberry, for the purpose of showing relationships. Simple technical terms may be introduced when required by the pupils.

5. The wheat-field. Planting, growing, cutting, threshing, marketing, grinding, baking.

6. Making collections of leaves, flowers, weeds, or such other specimens as the pupils are interested in.

ANIMAL LIFE.—

1. Special study of the meadow-lark, cow-bird, crow, robin, oriole, or other birds.

2. Comparative study to show how wings, bills, feet, color, and nests are suited to the lives of the different birds.

3. Incidental observation of the birds of the district.

4. A study of the spider as a house-builder and hunter; his habits, manner of moving, food, perseverance and other qualities. Stories of spiders.

5. The house moth. The eggs, the larvæ, the cocoon and the pupa, the imago, the egg; or a study of the wasp —a paper-maker, making the nest, feeding the young, guarding the young, the wasp in the winter season.

6. Incidental observation of the gopher and other wild animals of the district.

7. The dairy cow. Food, drink, habits, value to the home, gentleness, love for her young, her home instincts, etc. Treatment of the cow. Stories of the cow.

8. The domestic cat. Eating, drinking, sleeping, movements, senses. Adapted to mode of life. Relation to mice and birds. Stories of cats, tigers, lions, etc.

PHYSIOLOGY.—

1. Study of the human body; (*a*) Comparison with bodies of animals, adaptation. (*b*) Division of head, trunk, hands, limbs, feet.

2. Study of the organs of sense (practical). Hygiene pertaining to the above.

INANIMATE NATURE.—

1. Continued study of the physical features of the neighborhood. A special study of any local watercourse, reference

being made to source, course, outlet, slopes, channel, banks, bed, basin, watershed, tributary, current, rapids, shallows, winding, building, and wearing banks, delta. Work of streams. Relation of stream to farm, town and district. Life in the stream and on its banks. (*A preparation for the study of a river.*)

2. Drawing plan of school-room, school-house and grounds, home. Making a map of the district and recording the geographical facts discovered.

3. The study of the "earth as a whole"—an immense ball rotating on its axis and exposed to the light and heat of the sun. Cold, hot and temperate regions. Introduction and use of the terms "equator" and "poles." The land and the water-masses in continents and oceans. The position and names of these. The earth-plateau. The general character of the climate. Productions and peoples of each continent. The value of each continent to the others (a simple introduction to the meaning of *exports* and *imports*). The polar and the equatorial winds.

Note.—The foregoing should be taught largely from the school globe and the sand-map.

GRADE V

Elementary Science

Note.—

The work of Grades III and IV should receive the following extensions:—There should be greater emphasis placed upon the practical side of the work. Considerable attention may be given to manual-training, experiments, finding the reason of things, and practical application of knowledge. While retaining the spirit of Nature Study, the teacher's aim should be in the direction of a more logical argument, a more systematic treatment and a simple classification.

Plant Life.—

1. Trees. Care of individual trees, value of windbreaks, shade trees, bluffs, forests.

2. What becomes of the dead leaves, grass and trees?

3. Experimental work for the purpose of determining:—

(*a*) How many seeds will germinate out of a hundred seeds of each of the following: Stink-weed, Canada thistle, wheat, etc. Recording results.

(*b*) What plants and how many are produced during one season on any small area?

(*c*) Observation of the vegetation that will occupy a burned prairie, a burned woodland or a clearing.

4. Distinction between the root and the stem. Making a collection of roots and stems.

5. The study of leaves in relation to light. This work to be based on observation and experiment. The dandelion, bedstraw, horse-mint and shepherd's purse are suggested.

6. Comparative study of typical plants continued. Note resemblances and differences. At least eight plants to be considered.

7. Making a flower calendar for—April and May; September and October.

Animal Life.—

1. The value of birds. Their protection.

2. How birds conceal and disguise their nests.

3. Study of some birds of prey; habits, structure, flight, sense-discrimination, cunning, etc.

4. The study of some of our winter birds.

5. Incidental observation of birds and conversations based on them.

6. Insect life in relation to shade trees—aphis-fly, caterpillar and leaf gall of the maple suggested.

7. Rearing mosquitoes and butterflies from eggs in order to obtain life-histories.

8. Recognition of the ladybird beetle with a view to protecting it. Finding the larvæ on trees infested by aphides.

9. Observation of insect life in an old log, a rotten stump, a sand hill, etc.

10. Incidental observation of insect life.

11. A study of some of our mammals, as the deer, bear, wolf, rabbit, badger, gopher, etc.

12. A study of the common toad continued. Rearing the toad from the egg, the life of the young toad, the change from water to land, the life on the land. Domestication of the toad.

HUMAN PHYSIOLOGY.—

1. Our food and drink. Necessity of food and drink. The best kind of food. Cooking of foods. When and how we should eat and drink. Iced water, tea, coffee, candy, pickles, gum, tobacco and alcohol.

2. Digestion. Chewing the food, swallowing, the stomach. Hygiene pertaining to the above.

3. Breathing. Measuring the chest when the lungs are compressed and when the lungs are inflated. Number of breathing acts per minute. The importance of breathing good air.

4. The blood. (*a*) The pulse; number of beats of pulse per minute, when seated, when standing, when rested, when playing. (*b*) The veins and the arteries. (*c*) The heart.

5. The bones and the muscles.

PHYSICS.—

1. The study of solids, liquids and gases as to characteristic properties.

2. Heat. Sources, effects on solids, liquids and gases.

GRADE VI

See note under Grade V

PLANT STUDY.—

1. Experiments and observations to show the relations of water to plants, reference being made to the following:—

(*a*) The greater portion of the weight of plants is water.
(*b*) Vegetation is more luxuriant in damp ground and in rainy seasons.
(*c*) The plants must have water.
(*d*) This water is taken in by the roots.
(*e*) The leaves and branches of plants are arranged to form a system of water-troughs.
(*f*) The water passes through the stem and the leaves in definite channels.
(*g*) The surplus water is evaporated.

2. An examination of the plant societies found in some of the following situations:—

(*a*) By the roadside.
(*b*) Along a water-course.
(*c*) On alkaline grounds.
(*d*) On marshy grounds.
(*e*) In vacant lots.
(*f*) On the city boulevards.
(*g*) Along a portion of a railway track, etc.

In this study note should be made of the plants comprising each society; the plants predominating and thus giving character to the group. What conditions of sun, shade and soil seem to be most favorable to the well-being of each society?

3. Seed dispersal. By winds, by animals, by water, by special contrivances.

4. Comparing and drawing:—

(*a*) Cross-section of a young maple and a corn-stalk.
(*b*) The veining of the leaves of the above plants.
(*c*) The seed leaves of a maple or an oak and the seed leaves of a grain of corn.

5. An acquaintance with the appearance of a mushroom, a bracket fungus, a puff-ball, a horse-tail, and a fern, for the purpose of extending the meaning of "plant life."

6. The comparative study of the stink-weed and the shepherd's purse; the clover and the pea; noting resemblances and deepening the meaning of *relationship* among plants.

ANIMAL STUDY.—

1. Special study of the nighthawk, wren, blue jay, and rose-breasted grosbeak.

2. Comparison of typical scratchers, climbers, waders, swimmers, and perchers, noting common and distinctive characteristics.

3. Observation of the inter-dependence of insects and flowers.

4. Special study of the grasshopper. Finding the eggs, observing the young hoppers and the growth of their wings, the adult, the most favorable weather, food and how eaten, behavior in wet or in windy weather, etc.

5. Special study of the rabbit. Home and home life, habits, structure, enemies. A type of the "gnawers." Stories of rabbits.

6. What are our native wild animals? In what way are these animals adapted to the country?

7. What are the wild animals that formerly inhabited this province? Are their remains to be found? What led to their extinction?

PHYSICS.—

1. Water, its use. Hard and soft water. The character of the wells and the springs of the district.

2. Water as a solvent. The boiling of water.

3. Convection of heat. Reference to water and to air.

4. The heating and the ventilation of the school-room.

5. The lever in its three simple forms.

PHYSIOLOGY.—

1. Foods and food materials.

2. Digestion.

3. Food habits and cooking.

4. Circulation.

5. Respiration.

6. The frame work and motion of the body.

GRADE VII

NOTE.—

The work of this grade and the succeeding one should be similar in character to that of Grades V and VI, but should be still more scientific as to logical arrangement, systematic treatment and classification.

The relation to the practical affairs of everyday life should be made more prominent and as much opportunity as possible should be given to manual work by the pupils, *e.g.* making simple apparatus, performing suitable experiments, etc.

The interests in these grades are directed more toward economic values, toward the controlling of the forces of nature, toward the understanding of observed facts and toward the making of new applications of physical principles.

PLANT STUDY.—

1. How plants obtain food from the soil:—
   (*a*) Some substances are soluble and others are insoluble in water.
   (*b*) The former substances pass readily through the roots.
   (*c*) The food is left in the plants when the water has evaporated.
2. Uses of roots:—
   (*a*) They fix the plants in the soil.
   (*b*) They obtain nourishment from the soil.
   (*c*) They act in some cases as storehouses.
3. Leaves:—
   (*a*) Classified as persistent and deciduous.
   (*b*) Classified as foliage-leaves, scale-leaves, bract-leaves and floral-leaves.
   (*c*) Parts—blade, petiole, stipules.
   (*d*) Study of form and venation.
4. The arrangement of leaves as represented by the bedstraw, anemone, shepherd's purse and the mint.
5. The meaning of spines, tendrils, prickles and hairs.

6. The distribution of plant life as follows:—
   (*a*) Where is plant life most vigorous? Why?
   (*b*) Where is plant life least vigorous? Why?
   (*c*) What locations have the greatest variety of plant forms?
   (*d*) What locations have the least variety of plant forms?
   (*e*) What plants are found in the woods?
   (*f*) What plants are found in the alkaline grounds?
   (*g*) What plants are found in the cultivated fields?
   (*h*) What plants delight in a northern exposure? Why?
   (*i*) What plants delight in a southern exposure? Why?

7. The simple classification of fruits, the pupils to determine the basis of classification.

8. Observation of the order in which flowers open, reference being made to the shepherd's purse, the three-flowered avens, the buttercup and the dandelion.

9. Flower arrangements, reference being made to the mustard, the yarrow, the sun-flower, and either the carroway or the meadow parsnip.

Animal Study.—

1. The food supply of some of our wild birds. A commencement to be made in this grade and continued in the next.

2. A special study of the cat-bird, the downy woodpecker, the flicker and the tame or wild pigeon.

3. What birds tenant the nearest groves?

4. The relation of the English sparrow to our native song birds.

5. Study of the cockroach and the field cricket.

6. Simple classification of insects according to the character of the wings. The following is suggestive: Dragon-fly, locust or grasshopper, aphis, potato-beetle, moth, house-fly, and ant.

7. The insect pests of the ash-leaved maple and other shade trees.

8. The appearance, habits, food, home, etc., of the earth-worm. The value of the earth-worm to man. Difference between an earth-worm and a caterpillar; between a spider and a grass-hopper.

9. The gopher and the grain fields. The badger and the grain fields.

10. A comparison of the gopher and the red squirrel.

INANIMATE NATURE.—

1. Study of the soil. Testing the productiveness of the following by planting the same kind of seed in each:—

(*a*) Clay.
(*b*) Sand.
(*c*) Clay and sand.
(*d*) Clay and humus mixed.
(*e*) Sand and humus mixed.
(*f*) Clay, sand and humus mixed. Applications.

2. Sun-drying a pound of each of the above. Finding by weighing the dry remnants the amount of water lost in each case. Experimental work for the purpose of ascertaining which of the above will retain the moisture the longest when subjected to the continued heat of the sun. Applications.

3. Have the natural features of the district determined to any extent the locations of the dwellings of the people.

PHYSICS.—

1. Distillation. Meaning of term. A method of distilling. The story of a rain-drop.

2. Evaporation, reviewed, enlarged and applied.

3. Capillarity as shown by a lamp-wick, a piece of blotting paper, a lump of sugar, a cotton cloth, the soil. Applications.

4. The meaning and the value of the forces of adhesion and cohesion.

5. The pulley, and the wheel and axle.

PHYSIOLOGY.—

1. The kidneys and the skin, and their duties.
2. The care of the skin.
3. Stimulants and narcotics.
4. The nervous system.
5. The senses.
6. Health and disease.

GRADE VIII

See note under Grade VII

AGRICULTURE.—Outlined as follows:—

1. The plant, including the seed, the young plant, the plant and the water, the plant and the soil, the plant and the air, the structure and growth of plants, naming and classifying plants.
2. The soil. Nature and origin of soil, tilling and draining the soil, improving the soil.
3. Weeds.
4. Insects of the fields.
5. The rotation of crops.
6. The garden.
7. Bees and birds. The food supply of our wild birds, continued from Grade VII.
8. Forestry.
9. Roads.
10. The country-home.
11. The science of everyday life, including the atmosphere, water, heat, and a simple analysis of the air.

PHYSICS.—

A practical study of the inclined plane, as follows:—A type of machine; a machine cannot create work; what is gained in power is lost in speed; wasted work; the law of the inclined plane. Applications.

APPENDIX C

The Nova Scotia Nature Study Course

GENERAL DIRECTIONS

The noting, examination and study of the common and more important natural objects and laws of Nature as they are exemplified within the range of the school section or of the pupils' observation. Under this head, pupils should not be required to memorize notes or facts which they have not, at least to some extent, actually observed or verified for themselves. There should be a short "Nature Lesson" given every day on the daily collections and observations of the pupils themselves—not on the statement of teachers or books—the lesson always being based on the objects or observations. Many books on the list recommended for school libraries are useful guides to the teacher for portions of the work prescribed in some of the grades. These guide books are to be used only to show the teachers how to give such lessons. They are entirely prohibited as text-books for either pupil or teacher, for under no circumstances should "notes" from the books be given to pupils. All such studies must be from the objects. Observations under this head form some of the best subjects for English composition or drawing exercises in all grades.

In schools with pupils of several grades under one teacher (as in most rural schools), many of these lessons may profitably engage the whole school. In nearly all, either the whole senior or whole junior divisions of the school can take part. A skilful teacher can thus give profitable object lessons to several grades of scholars at once; at one time giving a Grade V lesson, at another time a Grade VI or Grade VII or Grade VIII lesson, which will also contain enough for the observation and interest of Grade I, Grade II, Grade III and Grade IV pupils. An object lesson given to the highest class can thus, to a certain extent, be made a good object lesson for all the lower classes. The older pupils will see more and think more.

It must be remembered that the memorizing of notes and facts merely stated to pupils is strictly forbidden under this head. Such memorizing is pure cram, and is injurious instead of being useful. The teacher may not have time to take up in class every object indicated in the Nature lessons of the course. In such cases the pupils should be given two or three objects nearly related to the typical specimen examined in school, with directions to search for and examine them at home, as illustrated in the specimen class lesson. Without much expenditure of time the teacher can note this work has been honestly attempted to be done by each pupil. The lessons must be direct from Nature itself, but under the guidance of the teacher, who can save time in bringing the pupils to the point desired by his more matured experience. They are intended to train the observing and inductive faculties, to show the true way of discovering something of the nature of the world which immediately surrounds us, and which is, and will continue to be, re-acting upon us in one manner or another. This knowledge is so much power over Nature, from which we have to win our material existence. It is also essential as an element in any true and useful system of philosophy.

More stress has been laid here on the natural history of each section than on elementary physics and chemistry. Not because physical phenomena are less important; but because the elements of these sciences are the same all the world over, and there is no end to the cheap and well-illustrated guides to practical work in them which will well suit a section in Nova Scotia as well as one in England or in the United States. But there are no such simple guides in the biology of each section, nor in many others of its scientific characters. The teacher, then, must become a student and master himself; for such exercises have special power in developing the habit of accurate observation (which is the soundest basis for any career, ranging from that of the poet and professional man to the tiller and lord of the soil, the tradesman, the manufacturer, the inventor) and in developing in connection with history and civics an intelligent attachment to both the material and the ideal features of our country.

APPENDIX D

The following is a list of bulletins of the Ontario Agricultural College, published by the Ontario Department of Agriculture, Toronto. They may be had free on application.

Birds of Ontario in Relation to Agriculture, by C. W. Nash.
Check List of the Birds of Ontario, by C. W. Nash.

Serial No.	Date.		Title.	Author.
111	Dec.	1900	Lucerne or Alfalfa	R. Harcourt.
112	Dec.	1900	Foul Brood of Bees	F. C. Harrison.
113	Mar.	1901	Sugar Beet Experiments in Ontario	A. E. Shuttleworth.
114	May	1901	Dairy Bulletin (see No. 143)	Dairy School.
115	July	1901	Comparative Values of Ontario Wheat for Breadmaking purposes	R. Harcourt.
			Notes on Varieties of Winter Wheat	C. A. Zavitz.
116	Aug.	1901	The Hessian Fly in Ontario	Wm. Lochhead.
117	Jan.	1902	Pasteurization of Milk for Butter-Making	H. H. Dean. and F. C. Harrison.
118	Jan.	1902	Yeast and its Household Use	F. C. Harrison.
119	April	1902	Ventilation of Farm Stables and Dwellings	J. B. Reynolds.
120	May	1902	Bitter Milk and Cheese	F. C. Harrison.
121	June	1902	Ripening of Cheese in Cold Storage compared with ripening in ordinary Curing Rooms	H. H. Dean. and F. C. Harrison.
122	June	1902	Spray Calendar	Wm. Lochhead.
123	July	1902	Cold Storage of Fruit	J. B. Reynolds. and H. L. Hutt.
124	Dec.	1902	Nature Study, or Stories in Agriculture	Staff, O.A.C.
125	Dec.	1902	Roup (A Disease of Poultry)	F. C. Harrison. and H. Streit.
126	April	1903	Peas and Pea Weevil	C. A. Zavitz. and Wm. Lochhead.
127	May	1903	Farm Poultry	W. R. Graham.
128	Aug.	1903	The Weeds of Ontario	F. C. Harrison. and Wm. Lochhead.
129	Dec.	1903	Bacon Production	G. E. Day.
130	Dec.	1903	Bacterial Content of Cheese cured at different Temperatures	F. C. Harrison. and Wm. T. Connell.
131	Dec.	1903	Ripening of Cheese in Cold Storage compared with Ripening in Ordinary Curing Room	H. H. Dean. and R. Harcourt.
132	Dec.	1903	Roup; An Experimental Study	F. C. Harrison. and H. Streit.
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134	June	1904	Hints in Making Nature Collections in Public and High Schools	W. H. Muldrew.
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145	June	1905	Butter Preservatives	H. H. Dean. and R. Harcourt.

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